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Copies of this publication are available upon request to:
Electrical Energy Branch
Energy, Mines and Resources Canada
580 Booth Street
Ottawa, Ontario
K1A 0E4

Aussi disponible en français, s'adresser à:
Direction de l'énergie électrique
Ministère de l'Énergie, des Mines et des Ressources
580, rue Booth
Ottawa (Ontario)
K1A 0E4

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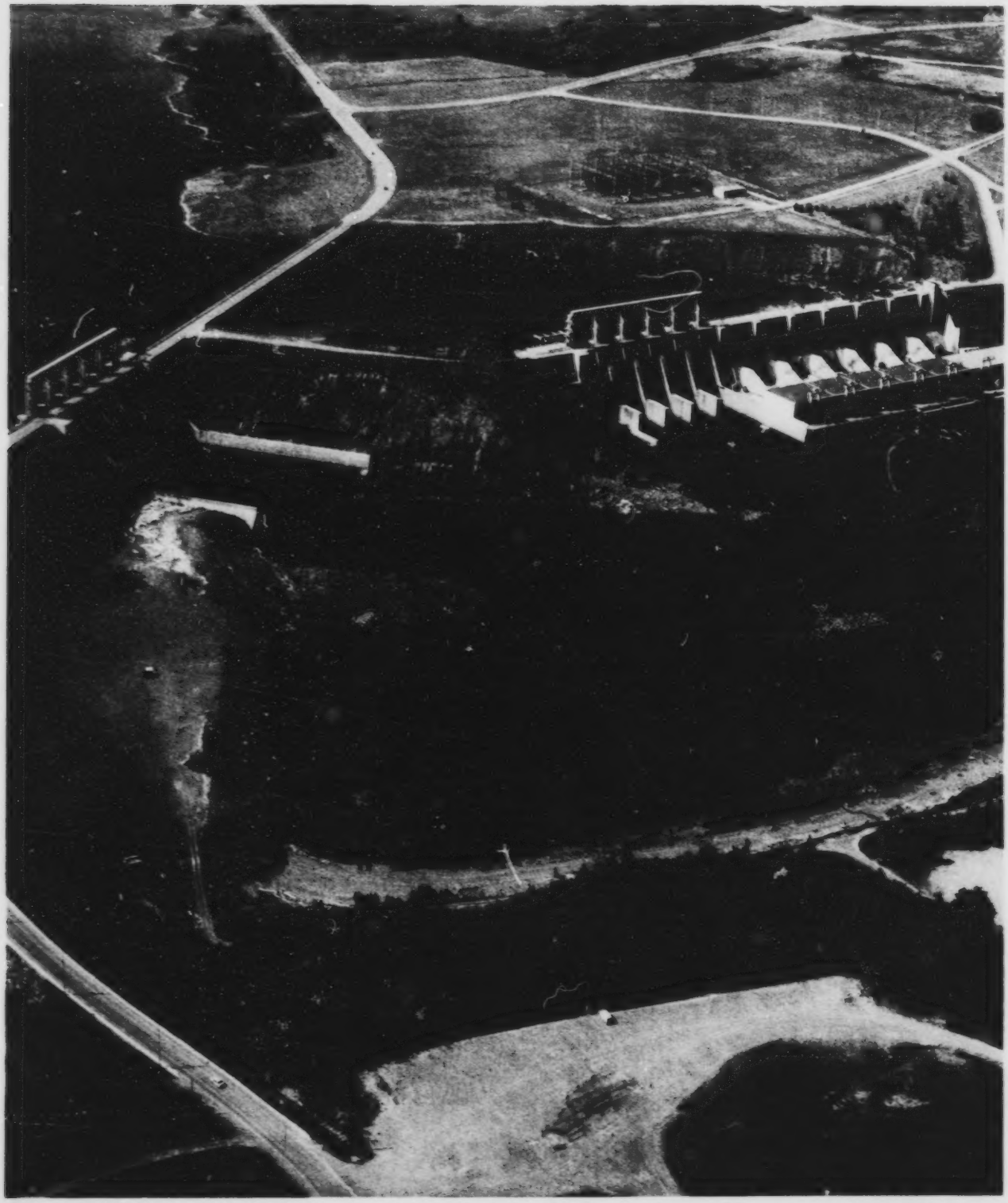


Mactaquac is the largest hydroelectric generating station in the Maritime provinces, with a capacity of 653 MW. It is owned by N.B. Power and is located on the Saint John River near Fredericton.

1. The Electric Power Industry in Canada

INDUSTRY STRUCTURE

Under the Canadian Constitution, electricity is primarily within the jurisdiction of the provinces. As a consequence, Canada's electrical industry is organized along provincial lines. In most provinces, the industry is highly integrated, with the bulk of the generation, transmission, and distribution provided by a few dominant utilities. Although some of these utilities are privately owned, most are Crown corporations owned by the provinces. The dominant utilities are listed in Table 1.1.

Among the major electric utilities, eight are provincially owned, four are investor owned, two are municipally owned, and two are territorial Crown corporations. In 1987, provincial electric utilities owned about 85.2 per cent of total installed generating capacity and produced about 83.5 per cent of total generated electricity. The four investor-owned utilities accounted for 5.8 per cent of all Canadian electric utility capacity and produced about 6.9 per cent of total electricity. Municipally owned utilities accounted for 1.2 per cent of capacity ownership, and produced 0.3 per cent of total generated electricity; two territorial Crown corporations accounted for 0.3 per cent and 0.2 per cent of capacity and generation respectively.

In addition to the 16 major electric utilities, there are about 60 industrial establishments generating electricity mainly for their own use. A few also sell energy to municipal distribution systems or utilities. These industries are concentrated in the pulp and paper, mining, and aluminum smelting sectors. In 1987, industrial establishments owned about 6.1 per cent of total capacity and produced about 7.1 per cent of total generated electricity in Canada, as shown in Table 1.2.

Table 1.1. Canada's major electric utilities by province

Province	Utility	Ownership
Newfoundland	Newfoundland and Labrador Hydro	Provincial
	Newfoundland Light & Power Co. Ltd.	Private
Prince Edward Island	Maritime Electric Co. Ltd.	Private
Nova Scotia	Nova Scotia Power Corporation	Provincial
New Brunswick	New Brunswick Electric Power Commission	Provincial
Quebec	Hydro-Québec	Provincial
Ontario	Ontario Hydro	Provincial
Manitoba	The Manitoba Hydro-Electric Board	Provincial
	City of Winnipeg Hydro-Electric System	Municipal
Saskatchewan	Saskatchewan Power Corporation	Provincial
Alberta	Alberta Power Ltd.	Private
	Edmonton Power	Municipal
	TransAlta Utilities Corporation	Private
British Columbia	British Columbia Hydro and Power Authority	Provincial
Yukon	Yukon Energy Corporation	Territorial
Northwest Territories	Northwest Territories Power Corporation	Territorial

Source: Energy, Mines and Resources Canada.

In addition to the major electric utilities and industrial establishments, there are about 364 smaller utilities across Canada, 87 per cent of which are located in Ontario. Most of these small utilities are owned by municipalities. They do not own generating capacity; instead, they usually purchase power from the major utility in their province. Several small investor-owned utilities, however, have their own generating capacity. In 1987, the small utilities accounted for 1.4 per cent of total Canadian capacity and produced 1.5 per cent of electrical energy.

ELECTRICITY AND THE ECONOMY

The electric power industry is a significant presence within the Canadian economy. As indicated in Table 1.3, there were about 91 000 people directly employed by the industry in 1986, about 1.0 per cent of total Canadian employment. Total revenue increased to about $17.4 billion in 1986 from $16.8 billion in 1985, an increase of 3.6 per cent. Of this total, approximately $1.1 billion or 6.3 per cent came from export earnings. The electric power industry has steadily increased its contribution to Canada's Gross Domestic Product, from 2.3 per cent in 1960, to 2.5 per cent in 1970, to 3.0 per cent in 1980, and 3.7 per cent in 1986.

Total assets of the industry were about $94.7 billion in 1986, accounting for about 7 per cent of the capital stock of the economy. This reflects the capital-intensive nature of the electric power industry. Ontario Hydro, HydroQuébec, and B.C. Hydro were the three largest electric utilities in Canada and, in terms of assets, ranked first, second, and fifth respectively among all Canadian companies.

Table 1.2. Electrical capacity and production by utilities and industrial establishments, 1930-1987

Year	Installed Generating Capacity		Energy Production	
	Utilities	Industrial Establishments	Utilities	Industrial Establishments
	(per cent)			
1930	83	17	93	7
1940	84	16	91	9
1950	83	17	88	12
1960	80	20	78	22
1965	82	18	77	23
1970	88	12	84	16
1975	90	10	87	13
1980	92	8	89	11
1981	92	8	90	10
1982	93	7	90	10
1983	93	7	90	10
1984	93	7	91	9
1985	93	7	92	8
1986	94	6	92	8
1987	94	6	91	8

Source: Electric Power Statistics, Volume II, *Statistics Canada, 57-202, 57-001.*

CANADIAN ELECTRIC UTILITIES

Newfoundland

In Newfoundland, the generation and distribution of electricity is dominated by two utilities, Newfoundland Light & Power Company Limited (NLPC) and Newfoundland and Labrador Hydro (NLH). Together, NLPC and NLH serve about 200 000 customers.

NLPC, an investor-owned utility, is the primary retailer of electricity on the island. NLPC was incorporated in 1966 through the amalgamation of St. John's Electric Light Company Limited, United Towns Electric Company Limited, and Union Electric Light and Power Company. Approximately 89 per cent of the company's power supply is purchased from NLH, with the balance generated by its own hydro stations.

NLH is a provincial Crown corporation, whose mandate is to generate and transmit electricity in the province. It was established by an act of the provincial legislature in 1954 and was incorporated in 1975. It is the parent company of a group that includes Churchill Falls (Labrador) Corporation (CFLCo), the Lower Churchill Development Corporation (LCDC), Twin Falls Power Corporation Limited, Gull Island Power Co. Ltd., and the Power Distribution District of Newfoundland and Labrador. NLH has 51 per cent ownership in LCDC; the Government of Canada owns the remaining 49 per cent. Through CFLCo, NLH owns and operates the Churchill Falls plant,

one of the largest power facilities in the world. NLH's on-island capacity is generated from oil and hydro sources.

Prince Edward Island

Maritime Electric Company Limited (MECL) is an investor-owned utility which has provided electricity service to Prince Edward Island since 1918. The company owns and operates a fully integrated electric utility system providing for the generation, transmission, and distribution of electricity throughout the island. MECL operates two oil-fired generating plants on the island, and it has a 10 per cent equity interest in New Brunswick Electric Power Commission's coal/oil-fired No. 2 unit located in Dalhousie, N.B. It leases from the P.E.I. government the submarine cable interconnection that connects the island to New Brunswick. MECL is the major distributor on the island, serving about 46 200 customers. A municipal utility in the town of Summerside has its own distribution system and purchases power from MECL.

Table 1.3. Electric utility assets, revenue and employees, 1986

Utility	Assets	Revenue	Employees
	($ millions)		(persons)
Major utilities			
Newfoundland and Labrador Hydro	2 095	321	1 333
Newfoundland Light & Power Co. Ltd.	367	245	905
Maritime Electric Co. Ltd.	91	54	203
Nova Scotia Power Corporation	1 475	476	2 383
New Brunswick Electric Power Commission	2 830	825	2 521
Hydro-Québec	30 588	4 734	20 796
Ontario Hydro	31 357	4 853	32 045
The Manitoba Hydro-Electric Board	3 240	570	4 142
City of Winnipeg Hydro-Electric System	111	84	643
*Saskatchewan Power Corporation**	2 857	847	3 181
TransAlta Utilities	3 700	916	2 527
Edmonton Power	954	271	846
Alberta Power Ltd.	1 338	375	1 371
*B.C. Hydro and Power Authority**	9 802	1 987	6 393
Northern Canada Power Commission	143	99	322
All minor utilities	375	700	11 547
Canada	94 698	17 357	91 158

** Includes natural gas operations.*

Source: Electric utilities' annual reports.

Nova Scotia

The Nova Scotia Power Corporation (NSPC) was incorporated in 1973. It is a provincial Crown corporation that produces and distributes electricity throughout the province. NSPC generates most of its electricity from thermal energy, with more than half of the production coming from coal. The utility also maintains hydro-generation and oil-fired facilities, and purchases power from New Brunswick. The largest portion of the province's total production is derived from the Lingan generating station located on Cape Breton Island. NSPC has two subsidiaries: Nova Scotia Light and Power Co. Ltd., and Eastern Light and Power Co. Ltd. In 1987, NSPC served about 350 000 customers.

New Brunswick

The New Brunswick Electric Power Commission (N.B. Power) was established by an act of the New Brunswick Legislature in 1920. The mandate of N.B. Power is to generate and distribute power under public ownership to all areas of the province. The utility owns and operates 14 generating stations, and electricity is generated from a balance of nuclear, hydro, and thermal sources. N.B. Power also purchases energy from Quebec. In 1987, N.B. Power directly provided electricity to 253 000 customers and indirectly served an additional 39 000 customers through sales to two municipal utilities.

Quebec

Hydro-Québec is a Crown corporation, established by the provincial Legislative Assembly in 1944. It is responsible for the generation, transmission, and distribution of most of the electricity sold in Quebec. Almost all of the electricity generated by Hydro-Québec at its stations throughout the province is from hydraulic sources. The utility currently serves more than 2.9 million customers.

Hydro-Québec has five wholly owned subsidiaries: the Société d'énergie de la Baie James, which carried out the construction of Phase 1 of La Grande complex; Hydro-Québec International, which provides engineering and consulting services abroad for electric power projects; Cedars Rapids Transmission Company Limited, which transmits export power to New York State; Somarex Inc., which will finance, construct, and operate a transmission line in the State of Maine; and Nouveler Inc., which promotes energy efficiency and alternative energy sources. Hydro-Québec is also a shareholder in Churchill Falls (Labrador) Corporation Limited, which operates the Churchill Falls power plant.

Ontario

Ontario Hydro is a provincially owned corporation, established in 1906 by the provincial legislature. It has broad powers to produce, buy, and deliver electric power throughout the province and currently operates under the Power Corporation Act. The main responsibility of Ontario Hydro is to provide power to the province's 316 municipal utilities, which in turn distribute power to their own customers. In 1987, more than 3.2 million customers were served by Ontario Hydro and the municipal utilities in the province. In addition, Ontario Hydro supplies about 100 major industrial users directly and about 780 000 rural retail customers in areas or communities not served by municipal utilities. Electricity generated by Ontario Hydro is from a balance of thermal, nuclear, and hydro sources.

In Ontario, there are also a number of small regional utilities. An example is Great Lakes Power Limited, a private hydroelectric generation and distribution utility operating in Sault Ste. Marie and the surrounding area. Great Lakes Power operates nine generating stations primarily located on two river systems flowing into the eastern end of Lake Superior, and is now developing additional capacity on the Magpie River. In 1987, the utility served almost 10 000 customers in Northern Ontario.

Manitoba

The Manitoba Hydro-Electric Board (Manitoba Hydro) is a Crown corporation established in 1949 by the provincial legislature. It has broad powers to provide electric power throughout the province and operates under the 1970 Manitoba Hydro Act. Almost all of the province's electric power is produced by Manitoba Hydro at its generating stations on the Churchill/Nelson river system in northern Manitoba. Manitoba Hydro distributes electricity to consumers throughout the province, except for the central portion of Winnipeg, which is served by the municipally owned Winnipeg Hydro. Manitoba Hydro and Winnipeg Hydro operate as an integrated electrical generation and transmission system. In 1987, Manitoba Hydro served about 360 000 customers directly, and Winnipeg Hydro served about 113 000 customers.

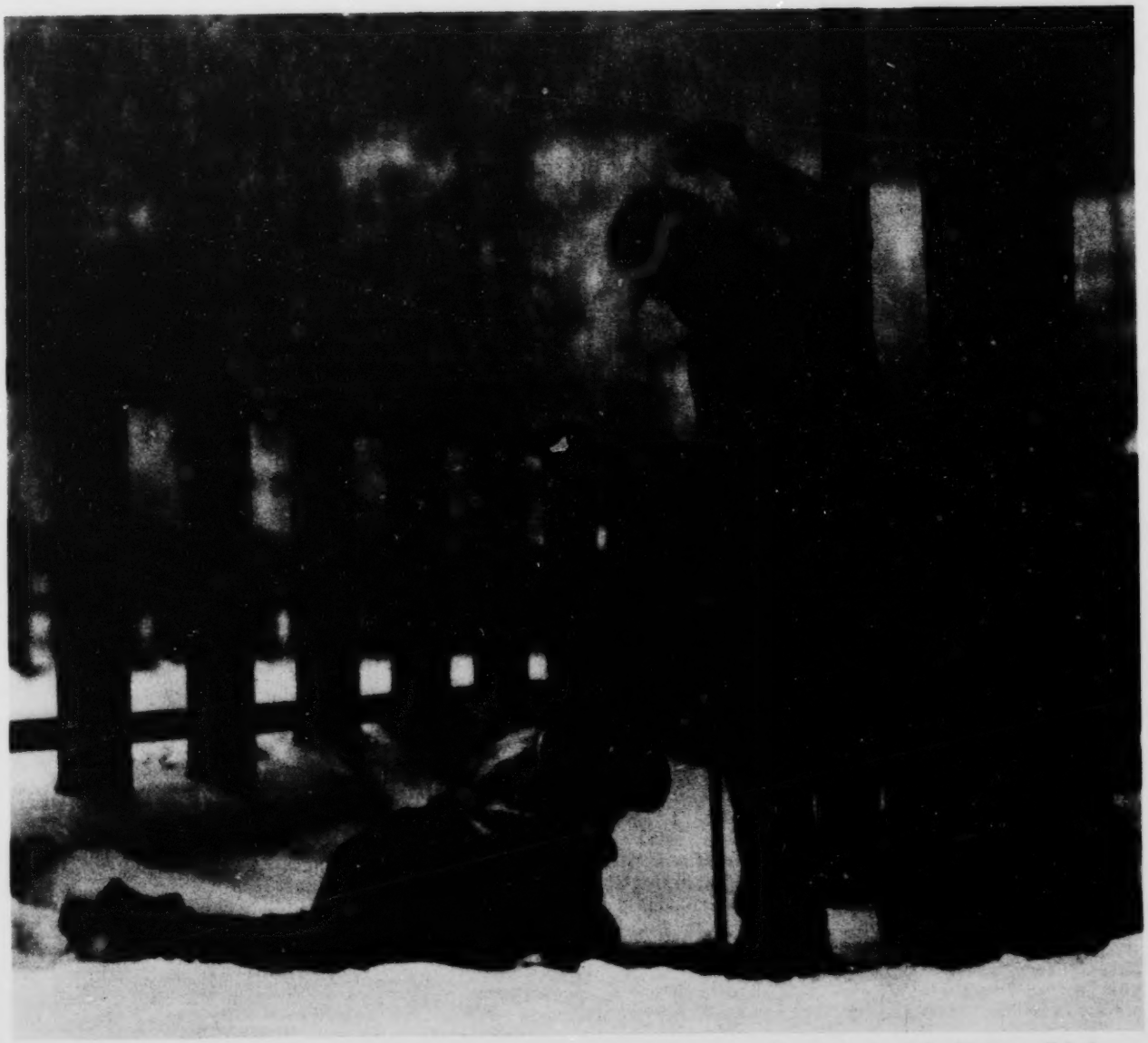
Saskatchewan

The Saskatchewan Power Corporation (SaskPower) is a Crown corporation operating under the 1950 Power Corporation Act. Under the Act, the mandate of SaskPower includes the generation, transmission, and distribution of natural gas and electricity. At the end of 1987, the corporation served more than 402 000 customers with electricity and 280 000 customers with natural gas. (In May 1988, the provincial government announced

its intention to separate the electricity and gas operations of SaskPower into separate Crown corporations.) The bulk of the electricity produced by SaskPower is from thermal sources.

Alberta

There are three major electric utilities in Alberta: TransAlta Utilities Corporation, Alberta Power Limited, and Edmonton Power. Together, they supply about 91 per cent of Alberta's electrical energy requirements. All are linked by a transmission network largely owned by TransAlta. The remaining 9 per cent of Alberta's electrical



Ontario Hydro technicians lower a pendulum to measure structural changes within the body of the McConnell Lake control dam. Ontario Hydro's dam safety program carefully monitors structures to ensure that changes resulting from fluctuating temperatures and water levels are within acceptable limits.

energy is supplied by industry. Almost 92 per cent of the electricity generated by Alberta utilities is produced by large coal-fired generating stations.

TransAlta Utilities Corporation, formerly Calgary Power Limited, is the largest investor-owned electric utility in Canada. The company was incorporated under the laws of Canada and has been engaged in the production and distribution of electricity in the Province of Alberta since 1911. About 71 per cent of the electric energy requirements of Alberta are supplied by the company, to over half of the population. In 1987, about 290 000 customers were served directly by TransAlta, while another 300 000 customers were served indirectly through wholesale contracts. TransAlta Utilities has four subsidiaries: TransAlta Resources Corporation; TransAlta Fly Ash Ltd.; Kanelk Transmission Co. Ltd.; and Farm Electric Services Ltd.

Alberta Power Limited, incorporated in 1972, is another investor-owned electric utility in Alberta, and a subsidiary of Canadian Utilities Ltd. The activity of the company is concentrated in east-central and northern Alberta. Alberta Power supplied about 19 per cent of the total Alberta electricity requirements in 1987, serving about 150 000 customers.

Edmonton Power has the largest generating capacity of any municipally owned utility in Canada. Since its creation in 1902, Edmonton Power has kept pace with the growth and development of Edmonton. Although the utility produced only 1.4 per cent of the electricity requirements of Alberta, it had a 15 per cent share of the total provincial market in 1987, serving more than 234 000 customers. Edmonton Power purchases most of its electricity from TransAlta Utilities and Alberta Power.

British Columbia

British Columbia Hydro & Power Authority (B.C. Hydro), incorporated in 1961, is a Crown corporation operating in British Columbia. B.C. Hydro provides electrical service throughout the province, with the exception of the southern interior, which is served by West Kootenay Power and Light Company, Limited. B.C. Hydro is the third largest electric utility in Canada and the largest distributor of natural gas in British Columbia. B.C. Hydro generates, transmits, and distributes electricity to more than one million customers in a service area which contains more than 90 per cent of the population of the province. B.C. Hydro also distributes natural gas and operates a provincial railway. Both of these responsibilities, as well as B.C. Hydro's research operations, are being privatized by the provincial government.

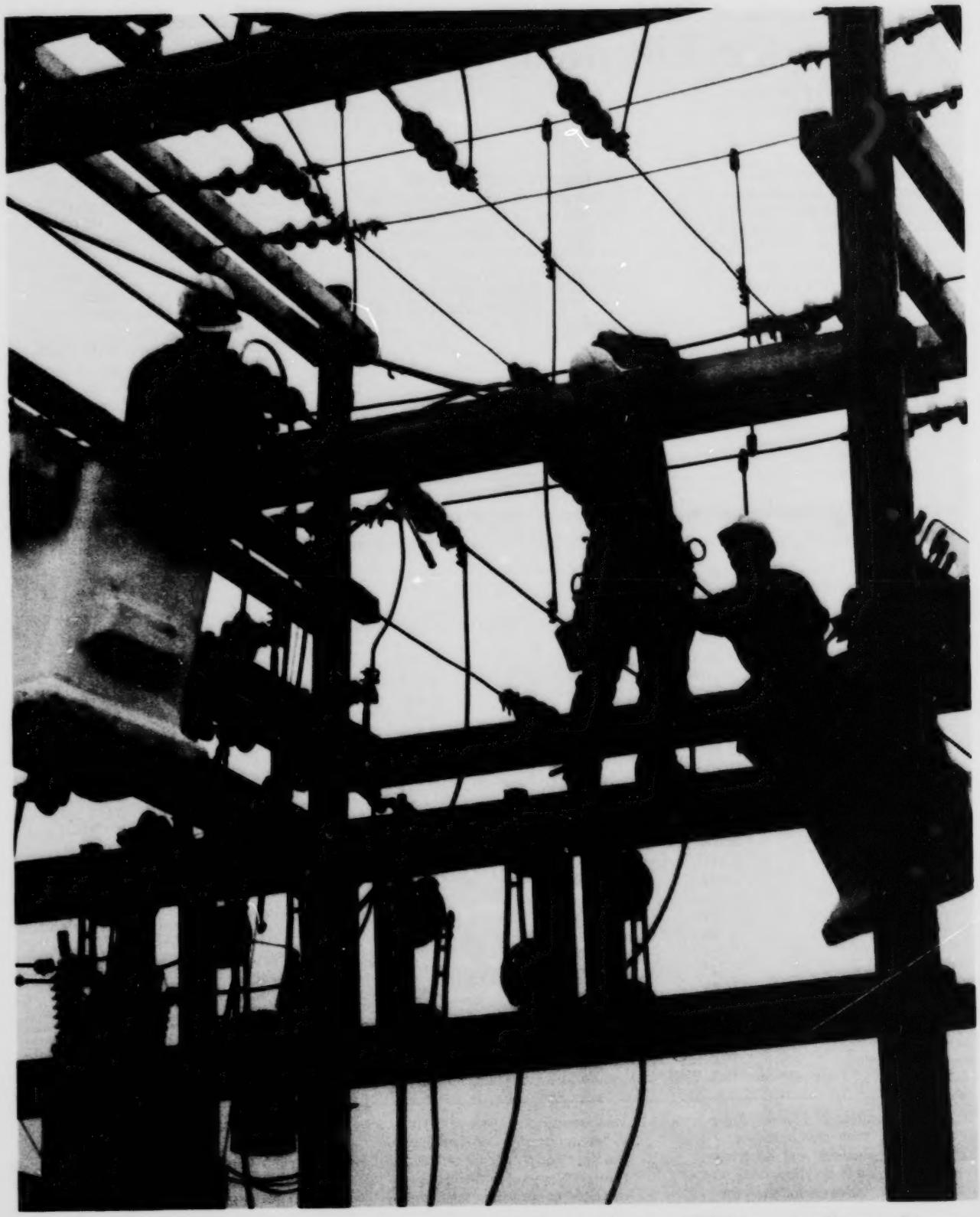
West Kootenay Power is an investor-owned utility supplying electric service in the southern interior of British Columbia. The company generates and distributes hydroelectricity directly to more than 60 000 customers in its service area. The company also supplies power to seven wholesale customers, who in turn serve almost 38 000 customers. In 1987, West Kootenay Power marked its ninetieth year of operation and, with the purchase of the company's shares by UtiliCorp United Inc. of Missouri, the end of a 71-year association with Cominco Ltd. The purchase was concluded in September 1987, following a review by the British Columbia Utilities Commission.

Yukon and Northwest Territories

From 1956 to 1987, the Northern Canada Power Commission (NCPC) was the principal agency generating and transmitting electrical energy in the Yukon and the Northwest Territories. By 1987, the NCPC was operating 50 separate power systems throughout the territories, serving approximately 15 000 customers. Electricity in the North is generated from a balance of hydro sources and diesel fuel.

In March 1987, the Government of the Yukon Territory and the federal government reached an agreement to transfer the Yukon portion of the NCPC from federal to territorial control and ownership. The Yukon government has placed ownership and control of the new company, the Yukon Energy Corporation, with the Yukon Development Corporation. The latter corporation was established under the Yukon Development Corporation Act in 1986. The Yukon Energy Corporation has entered into a management contract with the Yukon Electrical Co. Ltd., an existing Yukon electrical utility and a subsidiary of Alberta Power Limited, to operate the assets of the new utility, purchase the electricity generated, and distribute it to the Energy Corporation's customers. The Yukon Energy Corporation has assets worth $95 million.

In May 1988, the federal government reached a similar agreement with the Government of the Northwest Territories, transferring the N.W.T. portion of NCPC assets, worth $96 million, from federal to territorial control. Under the terms of the agreement, the territorial government assumes all responsibility for the utility, including rate-setting. A new territorial Crown corporation, the Northwest Territories Power Corporation, has been established to assume these responsibilities.



Newfoundland Light & Power Company employees carry out work at a substation. NLPC is continually upgrading its facilities to meet increased power needs in rural Newfoundland.

2. Canadian Electricity in the International Context

This chapter compares Canada's electricity supply and demand with those of selected other countries. All data used in this chapter were obtained from the United Nations' *Energy Statistics Yearbook*, with the exception of data on electricity prices, which were obtained from the *Quarterly Energy Review*, published by the Economist Intelligence Unit.[1]

INSTALLED GENERATING CAPACITY

At the end of 1985, total world electrical generating capacity was approximately 2418 GW. A breakdown of capacity by fuel type for the top 20 countries is shown in Table 2.1. Of the world total, conventional thermal accounted for 1608 GW (66.5 per cent); hydro 555 GW (22.9 per cent); nuclear 251 GW (10.4 per cent); and geothermal 4 GW (0.2 per cent).

The U.S. electric power industry was the largest in the world with a total generating capacity of 702 GW, accounting for 29 per cent of the total. The U.S.S.R. was second, with generating capacity of 319 GW; and Japan was third with 170 GW. The United States leads in installed capacity for every fuel type. U.S. conventional thermal accounted for more than 33 per cent of the world's thermal capacity; hydro for 15 per cent; nuclear for 33 per cent; and geothermal for 40 per cent.

Canada ranked fourth in the world with a generating capacity of about 99 GW, accounting for 4 per cent of the world total. In terms of fuel type, Canada's hydro capacity is the third largest in the world, next to the U.S. and U.S.S.R.; Canada's nuclear capacity is sixth in the

Table 2.1. International comparison of installed generating capacity, 1985

Country	Conventional Thermal	Hydro	Nuclear	Geothermal	Total
			(MW)		
United States	533 611	84 986	81 566	1 712	701 875
U.S.S.R.	229 936	61 257	28 100	0	319 293
Japan	110 291	34 337	24 686	214	169 528
Canada	30 937	57 458	10 889	0	99 284
West Germany	69 938	6 668	16 095	3	92 704
France	29 500	21 800	37 500	0	88 800
China	55 700	26 500	0	0	82 200
United Kingdom	56 352	4 190	7 064	1	67 607
Italy	36 098	17 166	1 273	439	54 976
India	34 969	15 115	1 096	0	51 180
Brazil	6 266	36 881	657	0	43 804
Spain	19 600	13 790	5 815	0	39 205
Sweden	8 018	15 690	9 455	5	33 168
Australia	24 570	6 557	0	0	31 127
Poland	27 063	1 975	0	0	29 038
South Africa	23 190	572	965	0	24 727
Mexico	17 059	6 601	0	425	24 085
Norway	245	22 991	0	0	23 236
East Germany	18 269	1 845	1 830	0	21 944
Czechoslovakia	14 632	2 875	2 040	0	19 547
World Total	1 607 712 (66.5%)	555 463 (22.9%)	250 697 (10.4%)	4 242 (0.2%)	2 418 114 (100%)

Source: Energy Statistics Yearbook, 1985, *United Nations, pp.324-351.*

[1] The 1986 edition of *Electric Power in Canada* compared installed generating capacity and electricity generation by fuel type among a number of countries for the year 1985. The data used in the comparison were obtained from various sources. This year, in order to obtain a consistency in the data and to permit an accurate comparison in the areas of installed generating capacity, energy generation, per capita consumption, demand growth, rates, and electricity trade, only United Nations' data have been used. Unfortunately, the most recent data available from the U.N. at this time are for 1985.

world, and its conventional thermal capacity is ninth.

ELECTRICITY GENERATION

During 1985, a total of 9675 TW.h of electricity was generated around the world. Of this total, conventional thermal, mainly from coal-fired stations, accounted for 6199 TW.h (64.1 per cent); hydro 1995 TW.h (20.6 per cent); nuclear 1453 TW.h (15 per cent); and geothermal 28 TW.h (0.3 per cent). Although nuclear accounted for only 10 per cent of the world total generating capacity in 1985, its energy production share was 15 per cent, indicating that most nuclear stations were operating at a relatively high capacity factor compared with conventional thermal stations and hydro plants. Generation by fuel type for the world's top 20 producers is shown in Table 2.2.

About 26 per cent of total world electricity generation took place in the United States in 1985. Its conventional thermal generation was 1848 TW.h, accounting for 30 per cent of the world conventional thermal total.

Canada was the largest hydro-electric energy producer in the world in 1985 with 304 TW.h, accounting for about 15 per cent of total hydro production. Canada's total production ranked fourth in the world (behind the United States, the U.S.S.R., and Japan), with total production of 460 TW.h, or 5 per cent of the world total.

The United States was the largest nuclear energy producer in the world in 1985, with a total of 384 TW.h or 27 per cent of the world nuclear total. As a proportion of total national electricity production, however, France's nuclear generation was the largest at about 65 per cent. Although Belgium was not among the top 20 electricity producers, its national nuclear proportion was the second largest at 61 per cent. Sweden ranked third at 43 per cent. Canada's nuclear share was a relatively small 13 per cent. The nuclear shares of the United States and the U.S.S.R. were 15 per cent and 11 per cent respectively.

DOMESTIC ELECTRICITY CONSUMPTION

In 1985, Norway consumed 24 777 kW.h of electricity per capita, more than any other country in the world. Canada was the third

Table 2.2. International comparison of electricity generation by fuel type, 1985

Country	Conventional Thermal	Hydro	Nuclear	Geothermal	Total
			(GW.h)		
United States	1 848 277	282 499	383 691	10 724	2 525 191
U.S.S.R.	1 168 000	206 000	170 000	0	1 544 000
Japan	424 427	87 947	159 578	1 460	673 412
Canada	95 045	304 302	61 061	0	460 408
China	318 300	92 400	0	0	410 700
West Germany	265 191	15 621	125 902	0	406 714
France	52 100	61 200	213 100	0	326 400
United Kingdom	229 533	4 095	61 094	0	294 722
Brazil	14 689	178 256	0	0	192 945
India	125 795	58 001	4 683	0	188 479
Italy	131 440	41 092	7 024	2 681	182 237
Poland	133 814	3 894	0	0	137 708
Sweden	6 740	71 166	58 637	0	136 543
Spain	66 117	31 408	28 035	0	125 560
South Africa	117 658	710	3 925	0	122 293
Australia	104 541	14 428	0	0	118 969
East Germany	99 337	1 758	12 739	0	113 834
Norway	339	102 851	0	0	103 190
Mexico	65 523	26 241	0	1 641	93 405
Czechoslovakia	64 499	4 349	11 779	0	80 627
World Total	6 198 662 (64.1%)	1 995 611 (20.6%)	1 453 181 (15.0%)	27 893 (0.3%)	9 675 347 (100%)

Source: Energy Statistics Yearbook, 1985, *United Nations, pp.380-407.*

largest per capita electricity user, at 16 522 kW.h. Table 2.3 reports electricity consumption per capita in 1985 for 25 countries. The first ten countries are listed according to their actual global rankings. The second group of countries are given in descending order of consumption; however, since only the most populous countries from each region were selected, the list does not indicate their true rankings in the world.

As Table 2.3 shows, per capita consumption varies significantly among countries. Norway consumed more than 12 times the world average; Canada, Iceland, and Sweden more than eight times; and the United States about five times. Nigeria's and India's per capita consumption levels were less than 13 per cent of the world average. Although China was the fifth largest electrical energy producer in the world, its per capita consumption was only 20 per cent of the world average.

Two principal factors contribute to Canada's large per capita consumption of electricity. Abundant water resources have permitted the development of economical hydroelectric power projects in various regions, making electrical energy relatively inexpensive and plentiful. This has led to relatively high electricity consumption among all energy users, and it has led many electricity-intensive industries to locate in Canada. As well, Canada's northerly location means a long and cold winter, resulting in much energy being used for space-heating purposes.

TOTAL ELECTRICITY CONSUMPTION GROWTH

World electricity consumption grew by approximately 4.5 per cent annually between 1983 and 1985. Table 2.4 reports total electricity consumption growth rates during the period 1983-85 for 25 selected countries around the world. In general, most of the countries with high consumption growth rates were developing countries. This was largely due to the fact that many of these countries have been engaged in the industrialization of their economies and, as a result, have increased their electrical energy consumption significantly.

Canada was one of the few developed countries with a high electricity consumption growth rate during the period 1983-85. Its average growth rate was 5.7 per cent, compared with 5.0 per cent for France and Japan, 3.2 per cent for the United States and West Germany, 2.9 per cent for Italy, and 2.8 per cent for the United Kingdom. The world average during the same period was 4.5 per cent. The United Kingdom, Italy, and most of the African countries were among the countries with the lowest consumption growth rates in the world.

ELECTRICITY TRADE

In both North America and Europe, there are substantial interconnections between electricity generating stations. Interconnections improve the economics and security of

Table 2.3. International comparison of per capita electricity consumption, 1985

Country	kW.h/Person	As Percentage of World Average
Norway	24 777	1 241
Iceland	16 642	834
Canada	16 522	828
Sweden	16 165	810
Qatar	11 159	559
Luxembourg	11 088	556
United States	10 781	540
Finland	10 588	531
New Zealand	8 066	404
Australia	7 579	380
East Germany	6 799	341
West Germany	6 722	337
Japan	5 577	279
France	5 545	278
U.S.S.R.	5 445	273
United Kingdom	5 232	262
South Africa	3 294	165
Spain	3 230	162
Argentina	1 481	74
Brazil	1 444	72
Mexico	1 182	59
Egypt	495	25
China	396	20
India	248	12
Nigeria	93	5
World Average	1 996	100

Source: Energy Statistics Yearbook, 1985, *United Nations, pp.408-421.*

electricity supply, and they reduce the level of capacity needed to meet peak loads. Interconnections also improve the flexibility of electricity supply, making it possible to minimize costs by replacing the highest cost generation, such as oil-fired generation, with imported hydroelectric energy.

In 1985, a total of 216 TW.h of electricity was exported internationally, accounting for 2.2 per cent of world production. The world's largest electricity exporters and importers are reported in Tables 2.5 and 2.6 respectively.

As indicated in Table 2.5, Canada was the largest electricity exporter in the world in 1985 with a total of 43.4 TW.h, accounting for 20 per cent of total world exports. France was second, exporting 28.8 TW.h, and the U.S.S.R. was third with 27.3 TW.h.

On the import side, the United States was the largest importer in 1985 with a total of 45.9 TW.h, or about 21 per cent of total world imports. Italy was second with imports of 25.1 TW.h; and West Germany was third with 18.8 TW.h. Although the United States was the largest importer, its total imports accounted for only 1.8 per cent of its total consumption in 1985. Luxembourg was the country most heavily dependent on electricity trade; it exported about 84 per cent of its production, and imported 98 per cent of its consumption.

ELECTRICITY INTENSITIES

Table 2.7 compares the intensity of electricity use in the economies of all 24 member countries in the Organization for Economic Co-Operation and Development (OECD) for the period 1960-85. Electricity intensity is defined as total electricity consumption per dollar of Gross Domestic Product (GDP). To facilitate the comparison, all currencies were converted into U.S. dollars at 1980 prices and

Table 2.4. International comparison of total electricity consumption growth rates

Country	1983	1984	1985	Average 1983-85
		(per cent)		
Indonesia	35.5	37.8	1.6	25.0
Jordan	26.9	20.1	7.3	18.1
Iraq	18.2	14.0	1.6	11.3
Thailand	12.4	11.1	9.5	11.0
India	7.6	11.7	11.8	10.4
South Korea	12.5	18.6	-0.3	10.3
Sweden	10.7	8.7	9.2	9.5
Kuwait	6.8	10.7	10.5	9.3
Malaysia	11.0	8.1	8.5	9.2
Iran	14.5	12.6	0.4	9.2
Syria	10.1	9.5	6.1	8.6
Brazil	7.3	9.9	7.9	8.4
Singapore	10.1	8.5	5.3	8.0
China	7.3	7.4	9.0	7.9
Turkey	4.4	12.6	6.5	7.8
Norway	6.8	5.8	5.4	6.0
Canada	4.6	7.1	5.3	5.7
Japan	6.6	4.5	4.0	5.0
France	2.4	5.4	7.3	5.0
Australia	0.9	6.3	5.3	4.2
U.S.S.R.	3.7	5.2	3.3	4.1
United States	3.0	4.5	2.2	3.2
West Germany	2.8	3.8	3.1	3.2
Italy	1.1	4.8	2.7	2.9
United Kingdom	1.6	1.8	5.1	2.8
World Total	4.1	5.5	4.0	4.5

Source: Calculated from Energy Statistics Yearbook, 1985, *United Nations, pp.408-421.*

exchange rates. Because of the limited availability of data, only OECD countries are included in the table. Among these countries, Norway had the highest electricity intensity, followed by Canada, Iceland, New Zealand, and Sweden. All five countries had electricity-GDP ratios greater than one in 1985.

All 24 OECD member countries experienced a time-trend increase in electricity intensity between 1960 and 1985, although some minor fluctuations occurred in the United States, Japan, the United Kingdom, Norway, and Luxembourg. Among the seven most industrialized countries, France had the fastest growth in electricity intensity during the period 1960-85, with an average annual increase of 2.0 per cent. France was followed by West Germany with 1.9 per cent, Italy with 1.6 per cent, the United States with 1.5 per cent, Canada with 1.1 per cent, the United Kingdom with 1.0 per cent, and Japan with 0.7 per cent.

In the United States, electricity intensity growth reached a peak in 1980, and then declined slightly and stabilized at the 1975 level. In Japan, electricity intensity grew modestly between 1960 and 1975; however, since then it has gradually declined to its 1970 level. The United Kingdom's electricity intensity grew strongly, by about 3.2 per cent annually between 1960 and 1970. Since then, it has declined steadily by 0.5 per cent per year for the period 1970-85.

Table 2.5. International comparison of electricity exports, 1985

Country	Exports* (GW.h)	Production (GW.h)	Percentage of Exports to Production
Canada	43 416	440 408	9.4
France	28 800	326 400	8.8
U.S.S.R	27 246	1 544 000	1.8
Switzerland	23 210	53 872	43.1
West Germany	16 330	406 714	4.0
Austria	7 770	43 923	17.7
Poland	7 568	137 708	5.5
Czechoslovakia	7 257	80 627	9.0
Sweden	6 675	136 543	4.9
Belgium	5 543	56 356	9.8
Spain	5 001	125 560	4.0
United States	4 965	2 525 191	0.2
Norway	4 618	103 190	4.5
East Germany	3 674	113 834	3.2
Zambia	3 100	10 090	30.7
Denmark	2 695	29 064	9.3
Uruguay	2 678	6 602	40.6
Yugoslavia	2 036	73 942	2.8
Hungary	1 924	26 779	7.2
Bulgaria	1 655	41 633	4.0
Italy	1 436	182 237	0.8
Portugal	1 284	19 007	6.8
Romania	1 000	75 268	1.3
Finland	878	47 098	1.9
Laos	723	1 350	53.6
Luxembourg	422	502	84.1
Netherlands	126	62 936	0.2
World Total	216 071	9 675 347	2.2

** Includes non-cash exchanges.*

Source: Energy Statistics Yearbook, 1985, *United Nations, pp.408-421.*

Table 2.6. International comparison of electricity imports, 1985

Country	Imports* (GW.h)	Consumption (GW.h)	Percentage of Imports to Consumption
United States	45 901	2 566 127	1.8
Italy	25 105	205 906	12.2
West Germany	18 829	409 213	4.6
Switzerland	14 512	45 174	32.1
Hungary	12 732	37 587	33.9
Czechoslovakia	10 796	84 166	12.8
Austria	6 051	42 204	14.3
Bulgaria	5 959	45 937	13.0
Finland	5 565	51 785	10.8
Belgium	5 497	56 310	9.8
Poland	5 456	135 596	4.0
France	5 400	303 000	1.8
Sweden	5 142	135 010	3.8
Netherlands	4 626	67 436	6.9
Norway	4 055	102 627	4.0
Luxembourg	3 945	4 025	98.0
Spain	3 927	124 586	3.2
East Germany	3 836	113 996	3.4
Portugal	3 530	21 253	16.6
Denmark	3 155	29 524	10.7
Canada	3 093	420 085	0.7
Zimbabwe	3 000	7 342	40.9
Brazil	2 781	195 724	1.4
Yugoslavia	2 663	74 569	3.6
Turkey	2 137	35 450	6.0
China	1 050	411 750	0.3
World Total	216 071	9 675 347	2.2

** Includes non-cash exchanges.*

Source: Energy Statistics Yearbook, 1985, *United Nations, pp.408-421.*

Table 2.7. International comparison of electricity consumption per unit of GDP

Country	1960	1965	1970	1975	1980	1985
			(kW.h/U.S. $1980)			
Norway	1.30	1.55	1.56	1.58	1.45	1.59
Canada	1.07	1.07	1.20	1.23	1.29	1.42
Iceland	0.48	0.44	0.84	0.97	0.98	1.07
New Zealand	0.51	0.63	0.73	0.87	0.98	1.03
Sweden	0.52	0.58	0.63	0.70	0.78	1.02
Finland	0.40	0.53	0.60	0.66	0.77	0.91
United States	0.60	0.65	0.80	0.88	0.89	0.87
Portugal	0.39	0.44	0.48	0.57	0.68	0.83
Luxembourg	0.64	1.06	0.78	0.97	0.87	0.80
Australia	0.37	0.46	0.51	0.58	0.66	0.74
Greece	0.19	0.25	0.39	0.50	0.58	0.69
Ireland	0.28	0.38	0.49	0.50	0.57	0.57
Spain	0.26	0.29	0.37	0.42	0.51	0.56
Japan	0.45	0.47	0.53	0.57	0.55	0.53
United Kingdom	0.41	0.50	0.56	0.55	0.53	0.52
Austria	0.42	0.44	0.46	0.47	0.49	0.52
Italy	0.34	0.39	0.42	0.46	0.48	0.51
West Germany	0.31	0.35	0.40	0.45	0.46	0.49
Turkey	0.15	0.20	0.26	0.32	0.43	0.48
Belgium	0.29	0.32	0.36	0.40	0.43	0.47
France	0.27	0.29	0.32	0.34	0.40	0.44
Switzerland	0.31	0.31	0.32	0.37	0.38	0.42
Denmark	0.15	0.21	0.30	0.33	0.39	0.41
Netherlands	0.21	0.26	0.32	0.36	0.38	0.39

Source: Real Gross Domestic Product in U.S. dollars was obtained from National Accounts, 1960-1985, *Department of Economics and Statistics, OECD, February 1987. Electrical energy data were obtained from* Energy Statistics Yearbook, *United Nations, various issues.*

ELECTRICITY PRICES

A comparison of international electricity prices is difficult because of different rate schedules and national currencies. Nevertheless, a reasonable comparison has been established by using average revenue per kilowatt hour in a given sector and converting to a common national currency.

Tables 2.8 and 2.9 summarize electricity prices for the industrial and residential sectors respectively. Due to the limited data available, only 17 countries are reported in the tables. Canada's electricity prices are highly competitive relative to the other countries. In the industrial sector in 1985, Norway had the lowest electricity price with 1.42 U.S. cents/kW.h, followed by Canada with 2.88 U.S. cents/kW.h, and Sweden with 2.91 U.S. cents/kW.h. In the residential sector, Canada had the lowest price with 3.61 U.S. cents/kW.h. Norway was second with 3.93 U.S. cents/kWh, and Sweden was third with 3.98 U.S. cents/kW.h.

In both sectors, Japan had the highest electricity prices compared with 16 other member countries in the OECD. Its electricity prices were about 3.2 and 3.4 times the respective industrial and residential prices of Canada in 1985.

Table 2.8. International comparison of electricity prices in the industrial sector, 1985

Country	Industrial Prices (U.S. cents/kW.h)	As Percentage of Canada's Price
Norway	1.42	49
Canada	2.88	100
Sweden	2.91	101
Australia	3.14	109
France	3.66	127
Finland	4.05	141
Netherlands	4.16	144
Belgium	4.29	149
Denmark	4.50	156
Spain	4.63	161
West Germany	4.72	164
Switzerland	4.84	168
United Kingdom	4.86	169
United States	5.16	179
Portugal	5.66	197
Italy	5.97	207
Japan	9.22	320

Source: Electricity prices in national currency units were obtained from Quarterly Energy Review, *Western Europe and Far East Asia, various issues in 1986 and 1987, the Economist Intelligence Unit. Exchange rates expressed in national currency units per 1985 U.S. dollars were obtained from* National Accounts, 1960-1985, *OECD, February 1987.*

Table 2.9. International comparison of electricity prices in the residential sector, 1985

Country	Residential prices (U.S. cents/kW.h)	As percentage of Canada's price
Canada	3.61	100
Norway	3.93	109
Sweden	3.98	110
Australia	5.17	143
Finland	5.24	145
Switzerland	5.94	165
United Kingdom	6.74	187
Portugal	7.52	208
Italy	7.70	213
United States	7.79	216
West Germany	8.29	230
Denmark	8.48	235
France	8.51	236
Spain	8.58	238
Netherlands	8.73	242
Belgium	10.14	281
Japan	12.16	337

Source: Electricity prices in national currency units were obtained from Quarterly Energy Review, *Western Europe and Far East Asia, various issues in 1986 and 1987, the Economist Intelligence Unit. Exchange rates expressed in national currency units per 1985 U.S. dollars were obtained from* National Accounts, 1960-1985, *OECD, February 1987.*

3. The Regulatory Structure

FEDERAL REGULATION

Constitutional Authority

Under the Canadian Constitution, legislative authority for electricity generation, transmission, and distribution rests primarily with the provinces. Federal authority regarding electricity is restricted to nuclear energy and international and interprovincial trade. Federal responsibility for electricity trade stems primarily from Section 91.2 of the Constitution Act, which gives the federal government broad authority over trade and commerce. Federal control of nuclear energy derives from sections 91.29 and 92.10 of the Act, which permits federal regulation of matters that are declared by Parliament to be for the general advantage of Canada.

Provincial ownership of most energy resources stems from Section 109 of the Constitution Act which, in turn, is supplemented by Section 92A of the Act, giving provincial legislatures authority over the development, conservation, and management of sites and facilities in the province for the generation and production of electrical energy. Under Section 92A, which was enacted in 1982, the provinces also have authority to make laws regarding interprovincial sales of electricity, as long as such laws do not conflict with federal laws and do not permit discrimination in prices or supplies exported to different parts of Canada.

National Energy Board[1]

The National Energy Board (NEB) is a federal tribunal, created in 1959 by an Act of Parliament. The Board's powers and duties are derived from the National Energy Board Act. Under the Act, the Board advises the federal government on the development and use of energy resources and regulates specific matters concerning oil, gas, and electricity. The Board's jurisdiction over electrical matters is limited to the certification of international and designated interprovincial power lines and the licensing of electricity exports from Canada. The Board has no jurisdiction over imports of electricity.

Part III of the NEB Act provides for the federal regulation of international power lines. When reviewing an application for an international power line, the Board determines whether the line is in the public interest by assessing i) the availability of electricity for export, ii) the existence of markets, iii) economic feasibility, iv) financing considerations and Canadian participation, and v) any other consideration that may be relevant. In making this determination, the Board holds public hearings. Applications accepted by the Board are subject to review by the Governor in Council. The Board may authorize, without a public hearing, the construction and operation of international power lines not exceeding 50 kV.

The Governor in Council may by order designate a particular interprovincial power line to be regulated in the same manner as international power lines. When power from one province simply enters the grid of another province, there is no federal regulation.

Part VI of the NEB Act provides for the regulation of electric power exports. The Board issues export licences in which it imposes terms and conditions on the licensees. The Act restricts the duration of licences to 25 years. In considering an export application, the Board is required to take into account all factors pertaining to the public interest. In particular, the Board must satisfy itself that i) the quantity of electricity to be exported is surplus to reasonably foreseeable domestic requirements, and ii) the price is just and reasonable.

In interpreting the latter requirement the Board has established three guidelines concerning the export price: i) it must recover its appropriate share of the costs incurred in Canada; ii) it must not be less than the price to Canadians for equivalent service in related areas; and iii) it must not be materially less than the least-cost alternative available to the foreign purchaser at the same location in the country of export. Under the Free Trade Agreement, which is expected to come into force on January 1, 1989, the third price guideline will be eliminated.

Before licensing exports, the Board normally conducts a public hearing. However, when the export quantities are small (i.e., not more than 60 MW and 400 GW.h year), or when emergency conditions exist, the Board may issue "orders," authorizing exports without a public hearing.

Atomic Energy Control Board

Immediately after World War II, Canada began to study the question of how to encourage the use of nuclear energy for peaceful purposes while at the same time preventing its use for weapons. In 1946, Parliament passed the Atomic Energy Control Act with these objectives in mind.

The Act gave the federal government control over the development, application, and use of nuclear energy and established the Atomic Energy Control Board (AECB). The five-person AECB administers and enforces the Act, and licenses uses of radioactive materials and activities involving nuclear energy. It also regulates

[1] A new electricity export policy is to be announced in September 1988.

the health, safety, security, and environmental aspects of nuclear energy. The AECB reports to Parliament through the Minister of Energy, Mines and Resources.

The Board's primary function is to license Canadian nuclear facilities and activities dealing with prescribed substances and equipment. Nuclear facilities include power and research reactors, uranium mines and refineries, fuel fabrication plants, heavy water plants, waste management facilities, and particle accelerators. Prescribed substances include uranium, thorium, heavy water, and radioisotopes. Activities relating to such substances, which may be licensed, include production, processing, sale, use, import, and export. Before issuing a licence, the Board ensures that the appropriate health, safety and security standards are met.

The AECB's control also extends to international security of nuclear materials and technology. Through the licensing process, it ensures that nuclear equipment and supplies are exported in accordance with Canada's obligations under the Treaty on the Non-Proliferation of Nuclear Weapons.

PROVINCIAL REGULATION

As noted above, under the Canadian Constitution the provinces have legislative authority over the generation, transmission, and distribution of electricity. In most provinces some form of regulation exists, and most provinces have established regulatory bodies to oversee the utilities, although the degree of supervision varies. The major areas subject to review are rate-setting and the construction of new facilities. The nature of provincial regulation with respect to these matters is described briefly below. The environmental regulations of the provinces are described in chapter 11.

Newfoundland

Newfoundland Light & Power Company (NLPC) and Newfoundland and Labrador Hydro (NLH) are regulated by the Newfoundland Board of Commissioners of Public Utilities. The Board fully regulates the rates and policies of NLPC, including the construction of new facilities. Since 1977, the Board has also had authority under the Electric Power Control Act to review NLH's rates for residential customers. The Board makes recommendations to the Newfoundland Cabinet, which is the final authority for utility rates.

Cabinet is also the final authority with respect to NLH's capital expenditure program. Proposals by NLH for new facilities must receive Cabinet approval before construction can begin. NLPC must receive the approval of the province's Board of Commissioners of Public Utilities before proceeding with the construction of new facilities.

Prince Edward Island

Maritime Electric Company Limited is regulated by the Public Utilities Commission of Prince Edward Island under the provisions of the Electric Power and Telephone Act. The Commission has decision-making authority over electric utility rates in the province and screens all proposals for the construction of new generation and transmission facilities. If the Commission believes that a new facility may adversely affect the environment, a formal environmental assessment review process is initiated. A description of this process is provided in chapter 11.

Nova Scotia

Since 1976, the Nova Scotia Board of Commissioners of Public Utilities, in accordance with the provincial Public Utilities Act, has had full decision-making power over the utility's rates and policies.

The Board's authority extends to the construction of new facilities, and utilities are required to apply directly to the Board when planning new generation or transmission facilities. As part of the review process, the Board holds public hearings, during which the utility presents its proposed project, costs, and alternative plans. Members of the public may intervene directly during a hearing. The Board of Commissioners is the final authority on new facilities.

New Brunswick

As a Crown corporation, New Brunswick Power reports to the provincial government through its chairman, who is a member of the Cabinet. Rates and operations are regulated by a nine-member Board of Commissioners appointed by the Lieutenant Governor of New Brunswick. The utility's chairman and vice chairman sit on the Board. The Board's recommendations are referred to the provincial Cabinet, which is the final regulatory authority. A bi-partisan Crown corporation committee also reviews utility rates and operations annually.

N.B. Power must receive approval from the Lieutenant Governor-in-Council before proceeding with the construction of new facilities. Although the Lieutenant Governor-in-Council is the final authority in this regard, its decision is based upon a recommendation from the Minister of Municipal Affairs and Environment, following an evaluation of the project's possible environmental impacts. New Brunswick's environmental impact assessment process is described in chapter 11.

Quebec

In Quebec, a committee of the National Assembly on labour and the economy reviews Hydro-Québec's long-term development plan, which includes any proposed rate changes. The committee then makes a recommendation to the Minister of Energy and Resources, who in turn makes a recommendation to Cabinet. Rate increases can therefore be implemented by Hydro-Québec only after they have been approved by Cabinet.

The construction of new facilities by Hydro-Québec can take place only after the utility has received an Order-in-Council from the provincial government. Before an Order is issued, the Department of the Environment and the Department of Energy and Resources must approve plans for the new facility. Other departments and agencies are also consulted.

Ontario

Ontario Hydro is a provincially owned corporation which reports to the government through the Minister of Energy. The management of Ontario Hydro is under the direction and control of its Board of Directors. Proposed rate changes are referred to the Ontario Energy Board (OEB), through the Minister of Energy, for examination at public hearings. However, it is the Board of Ontario Hydro that is authorized to set the utility's rates, and it may accept or reject the recommendations of the OEB.

On matters concerning its generation expansion program and transmission facilities, Ontario Hydro is regulated by the provincial Joint Hearing Board. The Board is composed of members from the Environmental Assessment Board and the Ontario Municipal Board. The Joint Board makes a recommendation to the provincial government, and final approval must be given through an Order-in Council.

Manitoba

Under the Manitoba Public Utilities Board Act, Manitoba Hydro's rates may be reviewed by the Manitoba Public Utilities Commission in response to a directive from the government or an application from one of Hydro's clients. The Public Utilities Board reports its recommendations to the Minister of Energy and Mines. The provincial Cabinet makes the final decision to approve or reject rates.

Under the 1988 Manitoba Environment Act, the provincial government must also approve major facility construction. Applications are made to the Minister of the Environment and a full environmental assessment is required. A description of Manitoba's environmental assessment review process is given in chapter 11.

Saskatchewan

Saskatchewan Power Corporation (SaskPower) is governed by a government-appointed Board of Directors that is responsible for the management and operation of the Crown utility. Proposals to increase rates or construct new generation or transmission facilities must be approved by the Board of Directors. The minister responsible for SaskPower is a member of the Board.

Alberta

TransAlta Utilities Corporation and Alberta Power Limited are regulated by the Alberta Energy Resources Conservation Board (ERCB) with respect to the development of generation and transmission facilities, coal mine developments, and changes in service areas. Thermal generating stations are issued permits, which are subject to Lieutenant Governor-in-Council approval, while hydro dam approvals require final authorization through the passage of a bill in the legislature. TransAlta's and Alberta Power's rates are regulated by the Alberta Public Utilities Board, under the provisions of the Public Utilities Board Act of 1980.

As a municipally owned utility, Edmonton Power is subject to the authority of Edmonton Council, as well as the various provincial regulatory bodies. Its rates and financing are regulated by city council, while the ERCB is responsible for the regulation of new generation and transmission facilities.

The three utilities participate in the cost-pooling program of the Electric Energy Marketing Agency (EEMA). The EEMA was established in 1982 by the provincial government to help equalize power costs throughout Alberta. Under EEMA legislation, the utilities' generation and transmission costs are regulated by the Public Utilities Board. The Board also approves the selling prices of electricity to EEMA, which then pools the utilities' costs and resells the power at average prices back to the utilities.

British Columbia

Electricity rate changes in the province of British Columbia require the approval of the British Columbia Utilities Commission (BCUC). Major generation and transmission projects require the approval of the provincial Cabinet. Upon receiving an application to construct a major facility, the government may refer the application to the BCUC for review and a recommended course of action. Projects which obtain Cabinet approval receive an Energy Project Certificate from the province.

Yukon and Northwest Territories

As noted in chapter 1, the federal government has sold the assets of the Northern Canada Power Commission (NCPC) to the territorial governments. The Yukon transfer was completed in 1987. The Yukon Energy Corporation, which is now the principal electrical utility in the territory, is subject to the regulations of the Yukon Utility Board, under the Public Utilities Act of 1986. Under the Act, the Corporation must file applications for rate changes or facility construction with the Board. The Board then reviews the application and makes a decision on the request.

The transfer of the NCPC to the Northwest Territories Power Corporation was completed in May 1988. The regulation of rates and new facilities is currently by the Government of the Northwest Territories. The N.W.T. Public Utilities Board Act is presently being revised, and it is expected that once the revision is complete, the N.W.T. Power Corporation will be regulated by the territorial Public Utilities Board. The scheduled date for completion of the revision is late 1989.

4. Electricity Consumption

ELECTRICITY AND PRIMARY AND SECONDARY ENERGY

Electricity constitutes a significant share of Canada's primary and secondary energy consumption. Primary energy refers to the amount of energy available to the final consumer, plus conversion losses and energy used by the energy supply industries themselves. Conversion losses refer to losses in the processing of refined petroleum products, for example, or losses due to thermal and mechanical inefficiencies resulting from the conversion of fossil fuels (coal, oil or natural gas) into electricity in thermal power generation. The contribution of electricity to total primary energy consumption has steadily increased from 29 per cent in 1960 to 45 per cent in 1987, as shown in Figure 4.1. In terms of volume, primary energy consumption delivered in the form of electricity increased from 1153 PJ in 1960 to 4739 PJ in 1987, an average annual growth of 5.4 per cent. This is about double the average annual growth of non-electric primary energy consumption of 2.7 per cent registered for the same period.

Secondary energy is the amount of energy available to, and used by, the consumer in its final form. Electricity constitutes a much smaller share of secondary energy consumption than primary energy consumption. Figure 4.2 indicates that electricity's share of Canadian secondary energy consumption was 11 per cent in 1960, and 24 per cent in 1987.

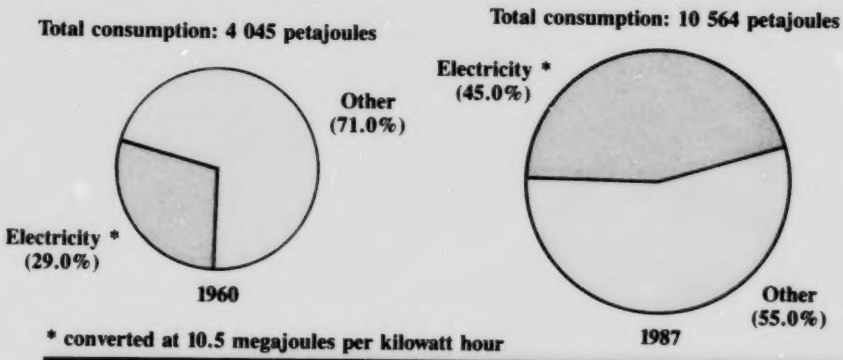
TOTAL ELECTRICITY CONSUMPTION

Total electricity consumption (demand) includes generation by electric utilities, generation by industrial establishments, and net imports (imports minus exports). Table 4.1 indicates that from 1960 to 1987, Canada's total electricity consumption has increased at an average annual rate of 5.3 per cent. For the period 1960-74, growth was rapid and fluctuated within a fairly narrow range, with an average annual growth rate of 6.6 per cent. After the first oil crisis of 1973-74, however, the growth rate declined to 4.2 per cent per year. In 1987, consumption increased by 3.9 per cent, up slightly from 3.7 per cent in 1986.

Of the total electricity consumed in Canada in 1987, 41 per cent was consumed in the industrial sector, 29 per cent in the residential sector, 22 per cent in the commerical sector, and 8 per cent in transmission and distribution losses, as shown in Table 4.2. Since 1960, consumption has grown steadily and most rapidly in the commercial sector (averaging 7.8 per cent per year from 1960 to 1987), while the industrial sector has experienced the lowest growth (averaging 3.7 per cent per year). In 1960, industrial consumption accounted for 60 per cent of total electricity consumption; since then it has gradually decreased and now appears to have stabilized around 42 per cent.

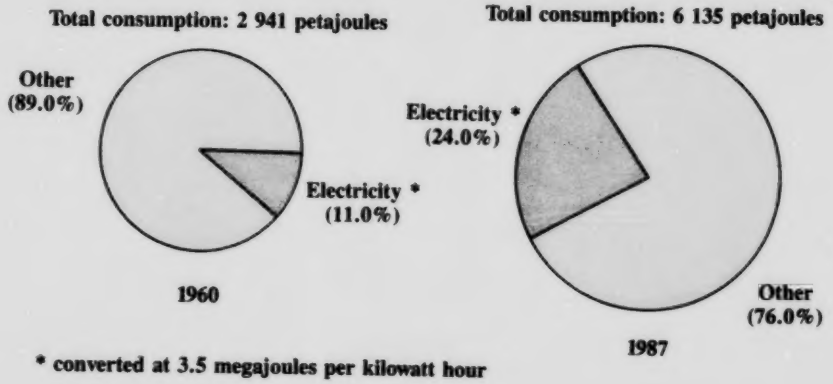
Electricity generation, trade, and consumption by province are given in Table 4.3. Quebec was the largest producing and consuming

Figure 4.1. Primary energy consumption in Canada



* converted at 10.5 megajoules per kilowatt hour

Figure 4.2. Secondary energy consumption in Canada



* converted at 3.5 megajoules per kilowatt hour

province in 1987, and also the largest international exporter. Total electricity generation, consumption, and net transfers are shown in Figure 4.3.

PER CAPITA ELECTRICITY CONSUMPTION

Table 4.4 reports per capita electricity consumption by province. As in the case of total consumption, per capita electricity consumption exhibited a high and low growth pattern before and after the oil crisis of 1973-74. For the period 1960-87, Saskatchewan had the highest growth rate of per capita electricity consumption, with an average of 7.5 per cent, followed by Prince Edward Island with 7.2 per cent, New Brunswick with 6.9 per cent, and Alberta with 6.6 per cent.

Table 4.1. Electricity consumption by province

	Electricity consumption (GW.h)								Average annual growth rate (per cent)			
	1960	1965	1970	1975	1980	1985	1986	1987*	1960-74	1975-87	1960-87	1986-87
Nfld.	1 427	2 684	4 770	6 206	8 545	9 658	9 712	9 697	11.5	3.8	7.4	-0.2
P.E.I.	79	137	250	421	518	578	622	647	11.9	3.7	8.1	4.0
N.S.	1 733	2 502	3 706	5 697	6 814	7 626	7 942	8 326	8.7	3.2	6.0	4.8
N.B.	1 684	2 905	4 221	6 713	8 838	10 514	11 658	12 376	10.1	5.2	7.7	6.2
Que.	44 002	52 229	69 730	89 932	118 254	144 761	151 838	158 196	5.4	4.8	4.9	4.2
Ont.	37 157	49 276	69 488	89 197	106 509	122 460	126 936	132 174	6.4	3.3	4.8	4.1
Man.	4 021	5 942	8 601	11 890	13 927	15 912	16 217	15 862	7.9	2.4	5.2	-2.2
Sask.	2 124	3 449	5 402	7 187	9 827	12 050	11 961	12 451	9.2	4.7	6.8	4.1
Alta.	3 472	5 603	9 880	15 246	23 172	33 295	34 659	36 588	10.7	7.5	9.1	5.6
B.C.	13 413	19 170	25 761	32 689	42 789	49 150	49 394	50 934	6.9	3.8	5.1	3.1
Yukon	89	109	220	352	381	252	344	433	9.3	1.7	6.0	25.6
N.W.T.	100	159	308	425	494	594	535	466	10.2	0.8	5.9	-12.7
Canada	109 304	144 165	202 337	265 955	340 068	406 859	421 818	438 150	6.6	4.2	5.3	3.9

** Preliminary data.*

Source: Electric Power Statistics, Volume II, *Statistics Canada, catalogue 57-202.*

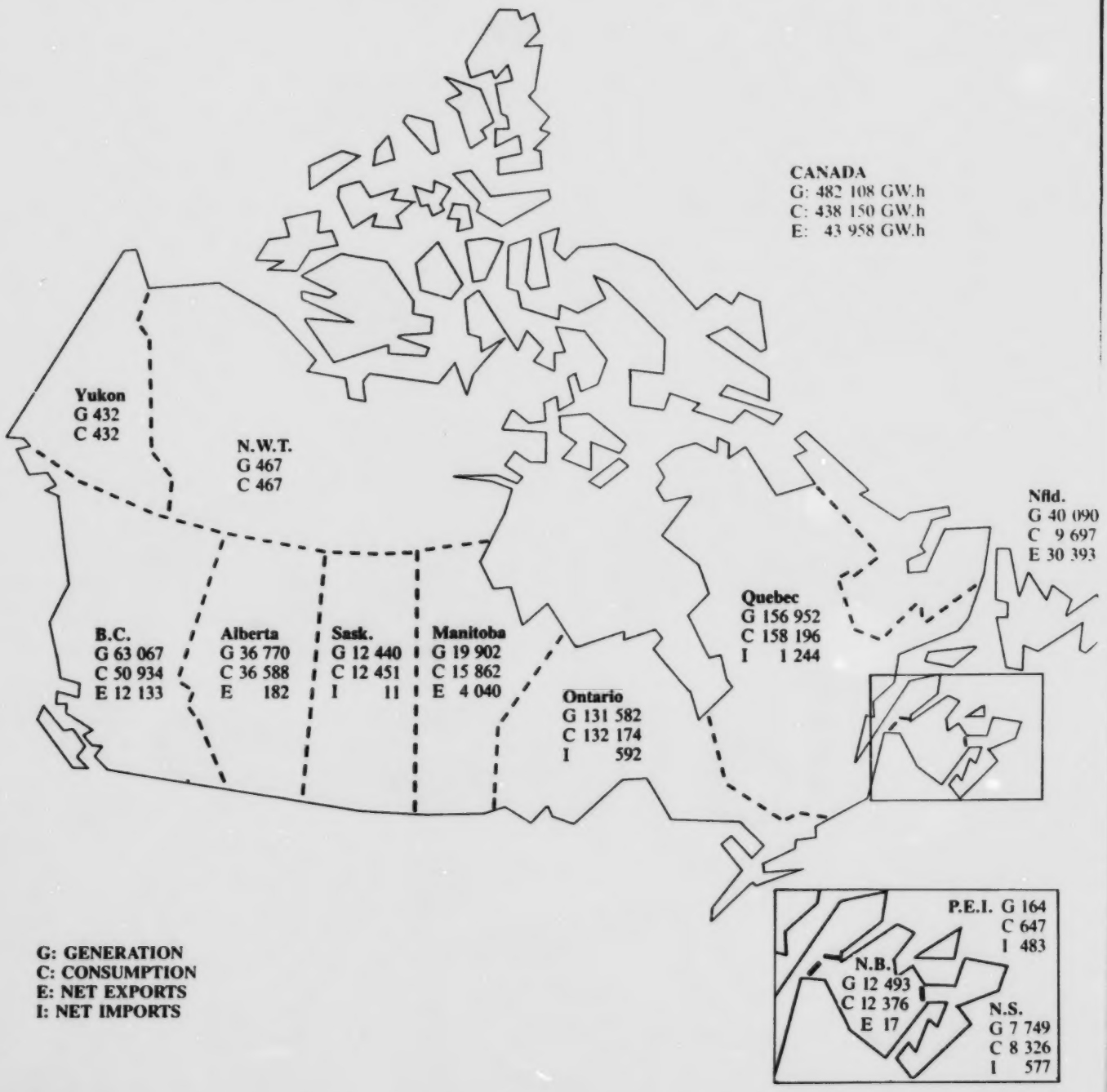
Table 4.2. Electricity consumption in Canada by sector

	Electricity consumption (GW.h)								Average annual growth rate (per cent)			
	1960	1965	1970	1975	1980	1985	1986	1987*	1960-74	1975-87	1960-87	1986-87
Residential	20 397 (19)	29 738 (20)	43 431 (21)	64 128 (24)	92 440 (27)	113 983 (28)	117 905 (28)	126 993 (29)	7.9	5.9	7.0	7.7
Commercial	12 632 (12)	23 859 (17)	44 068 (22)	65 744 (25)	75 912 (21)	85 320 (21)	92 148 (22)	96 927 (22)	12.4	3.3	7.8	5.2
Industrial	66 353 (60)	79 118 (55)	98 450 (49)	109 743 (41)	142 247 (42)	171 803 (42)	175 507 (42)	177 367 (41)	4.3	4.1	3.7	1.1
*Line losses***	9 920 (9)	11 450 (8)	16 388 (8)	26 340 (10)	32 469 (10)	35 753 (9)	36 258 (8)	36 863 (8)	6.5	2.8	5.0	1.7
Total	109 304 (100)	144 165 (100)	202 337 (100)	265 955 (100)	340 068 (100)	406 859 (100)	421 818 (100)	438 150 (100)	6.6	4.2	5.3	3.9

** Preliminary data.*
*** Losses during transmission and distribution.*
Figures in parentheses are percentage shares.

Source: Electric Power Statistics, Volume II, *Statistics Canada, catalogue 57-202.*

Figure 4.3. Electricity generation, consumption and net transfers, 1987 (GW.h)



G: GENERATION
C: CONSUMPTION
E: NET EXPORTS
I: NET IMPORTS

In 1987, Quebec was the largest electricity user in Canada with 23 720 kW.h per person, while Prince Edward Island was the smallest with 5043 kW.h per person. Quebec's per capita consumption was 39 per cent above the national average, while Prince Edward Island's was 71 per cent below the average. Quebec, British Columbia, New Brunswick, and the Yukon were the areas in which per capita consumption levels in 1987 were higher than the national average.

ECONOMIC GROWTH AND ELECTRICITY CONSUMPTION

Electricity consumption is affected by many factors: economic activity, demographic variables, electricity prices, other energy prices, conservation, technological changes, and weather. However, aggregate economic activity (as

Table 4.3. Provincial electricity generation, trade and consumption, 1987

	Generation	Imports from		Exports to		Consumption
		Provinces	U.S.A.*	Provinces	U.S.A.*	
Nfld.	40 090	0	0	30 393	0	9 697
P.E.I.	164	483	0	0	0	647
N.S.	7 749	659	0	82	0	8 326
N.B.	12 493	6 922	266	1 164	6 141	12 376
Que.	156 952	30 427	0	12 782	16 401	158 196
Ont.	131 582	6 992	2 113	16	8 497	132 174
Man.	19 902	1 220	512	2 311	3 461	15 862
Sask.	12 440	1 262	84	1 222	113	12 451
Alta.	36 770	526	2	710	0	36 588
B.C.	63 067	710	493	521	12 815	50 934
Yukon	432	0	0	0	0	432
N.W.T.	467	0	0	0	0	467
Canada	482 108	49 201	3 470	49 201	47 428	438 150

* *Service exchange is included.*

Source: Energy, Mines and Resources Canada.

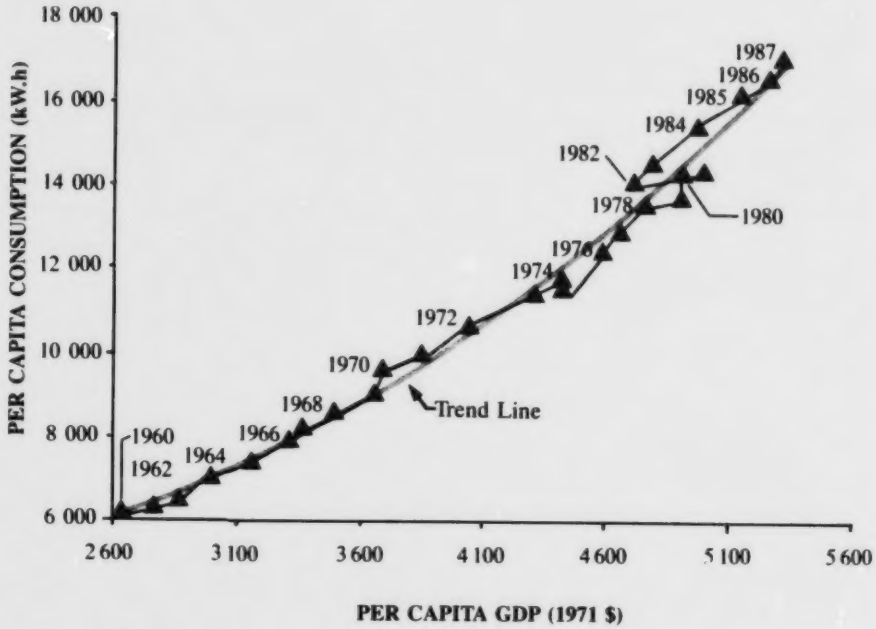
Table 4.4. Per capita electricity consumption by province

	Per capita consumption (kW.h/person)								Average annual growth rate (per cent)			
	1960	1965	1970	1975	1980	1985	1986	1987	1960-74	1975-87	1960-87	1986-87
Nfld.	3 184	5 500	9 226	11 304	14 758	16 632	16 739	16 745	10.1	3.3	6.3	0.0
P.E.I.	765	1 257	2 273	3 598	4 177	4 608	4 852	5 043	11.1	2.9	7.2	3.9
N.S.	2 385	3 310	4 739	6 948	7 988	8 668	8 986	9 370	7.9	2.5	5.2	4.3
N.B.	2 864	4 724	6 732	10 095	14 850	16 058	16 167	17 115	9.2	4.5	6.9	5.9
Que.	8 565	9 187	11 597	14 555	18 735	21 991	22 911	23 720	4.1	4.2	3.8	3.5
Ont.	6 086	7 259	9 203	10 915	12 422	13 510	13 825	14 205	4.3	2.2	3.2	2.8
Man.	4 932	6 158	8 750	11 726	13 521	14 863	15 035	14 649	6.3	1.9	4.1	-2.6
Sask.	1 750	3 631	5 741	7 924	10 131	11 839	11 715	12 169	11.6	3.6	7.5	3.9
Alta.	2 695	3 864	6 194	8 575	11 135	14 120	14 505	15 277	8.4	4.9	6.6	5.3
B.C.	8 386	10 680	12 124	13 433	16 220	17 038	16 998	17 356	3.9	2.2	2.7	2.1
Yukon	4 589	7 569	11 957	16 526	17 085	10 862	15 026	18 633	8.7	1.0	5.3	24.0
N.W.T.	5 304	5 540	8 851	10 316	11 052	11 647	10 507	9 174	3.5	-1.0	2.1	-12.7
Canada	6 184	7 339	9 501	11 718	13 112	16 043	16 633	17 121	4.9	3.2	3.8	2.9

Source: Electrical Energy Branch, Energy, Mines and Resources Canada.

measured by the Gross Domestic Product) is the most important variable. The historical relationship between per capita GDP and per capita electricity consumption is shown in Figure 4.4.

Figure 4.4. Historical relationship between electricity demand and GDP, 1960-1987



PEAK DEMAND

Peak demand is the annual maximum average net kilowatt load of one hour duration within an electrical system. For Canada as a whole, as shown in Table 4.5, peak demand grew from 17 264 MW in 1960 to 71 418 MW in 1987, an average annual growth rate of 5.4 per cent. In comparison, total consumption during the same period grew at an average annual rate of 5.3 per cent. In 1987, peak demand grew 1.9 per cent, up from a negative growth rate of 1.3 per cent in 1986.

LOAD FACTOR

Load factor is defined as the ratio of average demand to peak demand in any given period. More precisely, it is the energy demand in kilowatt-hours divided by the product of the number of hours in the period multiplied by the peak demand in kilowatts. (In a year-base average, demand equals annual energy consumption divided by 8760 hours per year.)

Table 4.6 indicates that for the electric power industry in Canada as a whole, load factor has declined since 1960. At that time the industry load factor was 72.3 per cent. This was gradually reduced to about 67 per cent in 1970, and to 66 per cent in 1980. In 1987, it was 70 per cent.

Table 4.5. Peak demand by province

	Peak demand (MW)								Average annual growth rate (per cent)			
	1960	1965	1970	1975	1980	1985	1986	1987*	1960-74	1975-87	1960-87	1986-87
Nfld.	245	422	763	1 031	1 538	1 510	1 630	1 570	12.5	1.6	7.1	-3.7
P.E.I.	21	35	55	85	104	93	95	91	11.7	0.6	5.6	-4.2
N.S.	356	457	814	998	1 197	1 360	1 372	1 445	8.6	3.1	5.3	5.3
N.B.	319	528	726	1 101	1 699	1 888	2 063	2 210	10.8	6.0	7.4	7.1
Que.	5 871	8 228	11 127	15 114	20 680	25 618	25 049	25 885	7.8	4.6	5.7	3.3
Ont.	6 391	8 596	12 048	15 570	17 767	21 533	21 570	21 442	6.5	2.7	4.6	-0.6
Man.	772	1 022	1 565	2 326	2 681	2 932	2 981	2 992	8.3	2.1	5.2	0.4
Sask.	418	653	1 028	1 318	2 085	2 202	2 129	2 126	9.7	4.1	6.2	-0.1
Alta.	714	1 121	1 894	2 713	3 879	5 259	5 233	5 207	11.1	5.6	7.6	-0.5
B.C.	2 123	3 058	4 492	5 797	7 384	8 487	7 800	8 271	8.2	3.0	5.2	6.0
Yukon	19	16	39	66	75	53	69	68	9.4	0.3	4.8	-1.5
N.W.T.	15	31	41	68	81	96	120	111	11.8	4.2	7.7	-7.5
Canada	17 264	24 167	34 592	46 187	59 170	71 031	70 111	71 418	7.8	3.7	5.4	1.9

* *Preliminary data*

Source: Electric Power Statistics, Volume I, *Statistics Canada, catalogue 57-204.*

Table 4.6. Load factor by province

	1960	1965	1970	1975	1980	1985	1986	1987
	(per cent)							
Nfld.	66.5	72.6	71.4	68.7	65.3	64.5	68.0	70.5
P.E.I.	66.4	65.4	65.8	65.4	68.4	64.9	74.7	81.2
N.S.	59.5	66.4	62.7	58.4	59.3	62.0	66.1	65.8
N.B.	58.0	60.3	60.0	62.2	53.8	62.5	64.5	63.9
Que.	85.6	72.5	71.5	67.9	65.3	64.5	69.2	69.8
Ont.	66.4	65.4	65.8	65.4	68.4	64.9	67.2	70.4
Man.	59.5	66.4	62.7	58.4	59.3	62.0	62.1	60.5
Sask.	58.0	60.3	60.0	62.2	53.8	62.5	64.1	66.9
Alta.	55.5	57.1	59.6	64.2	68.2	72.3	75.6	80.2
B.C.	72.1	71.6	65.5	64.4	66.2	66.1	72.3	70.3
Yukon	53.5	77.8	64.4	60.9	58.0	54.3	56.9	72.7
N.W.T.	76.1	58.6	85.8	71.3	69.6	70.6	50.9	47.9
Canada	72.3	68.1	66.8	65.7	65.6	65.1	68.5	70.0

Source: Calculated from Electric Power in Canada, 1987, *Tables 4.1 and 4.5.*

A SaskPower transmission line maintenance crew changes a damaged insulator on the 230-kV line from Resdin, Manitoba, to Boundary Dam power station near Estevan.

5. Electricity Generation

SOURCES OF GENERATION

Canada's electric power industry began in the 1880s with electricity generated by steam. In the beginning, electricity was used mainly for home and street lighting. In the late 1880s and 1890s, the invention of the electric motor dramatically changed the industry from one that mainly provided nighttime power for lighting to one that also provided power for transportation and industry needs 24 hours a day. Following this, hydroelectric development spread rapidly, due to Canada's abundance of water resources. In 1920, hydro accounted for more than 97 per cent of total electricity production in Canada. This percentage declined slightly to 95 per cent by 1950, and 92 per cent by the end of 1960. By 1987, hydro production had further declined to 65 per cent.

Although thermal generation, mainly from coal-fired stations, has been a part of Canada's generation mix since the beginning of the electric power industry, for many years its share of total production did not increase significantly because of its relatively high cost of production. However, by the 1960s and 1970s, when most of Canada's economical hydro sites had been developed, the situation changed and thermal generation became competitive. Between 1950 and 1974, the growth rates of real fossil-fuel prices (coal, oil, and natural gas) were negative, and this led most electric utilities to consider building more thermal stations. As Table 5.1 indicates, thermal generation accounted for only 7 per cent of the total generated electricity in 1960. However, its production share jumped to 19 per cent by 1965, 23 per cent by 1970, and reached a peak of 25 per cent in 1974. After the first oil crisis of 1973-74, the share of thermal production gradually declined to 22 per cent by 1980, 20 per cent by 1985, and then stabilized at 20 per cent at the end of 1987.

After 1975, nuclear production emerged as an important source of electricity generation in Canada. Canadian nuclear power began in 1962 when the 25-MW Rolphton station went into operation in Ontario. In 1965, nuclear generation totalled only 88 GW.h, accounting for less than 0.1 per cent of total generated electricity in Canada. By 1975, nuclear generation accounted for more than 4 per cent of total electricity production. Most of the nuclear generation came from the first four Pickering stations in Ontario, which were completed between 1971-73.

By 1980, the nuclear production share increased to about 10 per cent of Canada's total with the completion of four of Ontario's Bruce stations, which were commissioned during the period 1976-79.

By 1985 nuclear generation accounted for 13 per cent of Canada's total generated electricity. During the period 1980-85, seven new nuclear stations were brought into service. They were Gentilly 2 in Quebec; Point Lepreau in New Brunswick; and Pickering stations 5, 6, and 7 and Bruce stations 5 and 6, all located in Ontario. In 1987, Pickering 8 and Bruce 7 went into operation, increasing the nuclear generation share to 15 per cent of Canada's total production.

Tidal power has to date played an insignificant role in electricity generation in Canada. However, it is worth noting that the 20-MW Annapolis tidal power plant in Nova Scotia, which began operation in 1984, is the first of its kind in North America.

Electricity generation increased 5.8 per cent in 1987 to 482 108 GW.h. Of this total, 438 150 GW.h was for use in Canada, and the remainder was exported. The sources of generation are given in Table 5.1, and the major generating

Table 5.1. Sources of electricity generation

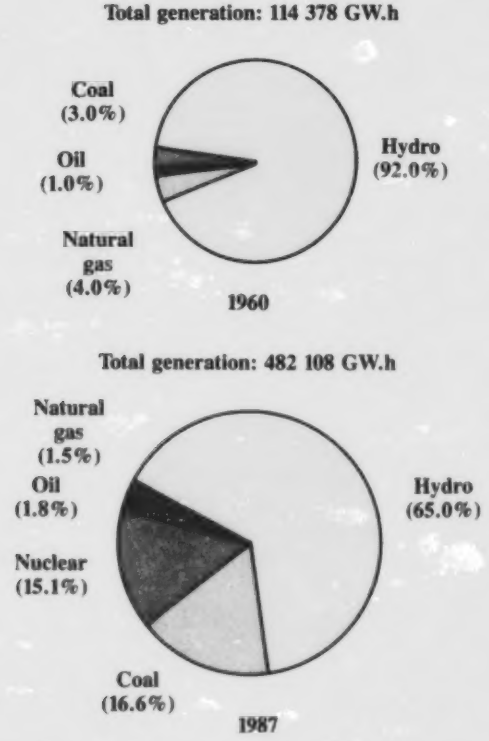
Fuel Type	Electricity Generation								Average annual growth rate			
	1960	1965	1970	1975	1980	1985	1986	1987	1960-74	1975-87	1960-87	1986-87
	(GW.h)								(per cent)			
Hydro	105 883	117 063	156 709	202 396	251 217	301 250	307 593	313 189	5.1	3.7	4.1	1.8
Thermal	8 495	27 123	47 045	59 138	80 207	88 842	80 936	96 031	14.3	4.1	9.4	18.7
*Nuclear**	-	88	969	11 858	35 882	57 067	67 233	72 888	-	16.3	-	8.4
*Tidal***	-	-	-	-	-	23	33	30	-	-	-	-9.1
Total	114 378	144 274	204 723	273 392	367 306	447 182	455 795	482 108	6.6	4.8	5.5	5.8

* *Commercial operation started in 1968.*
** *Commercial operation started in 1984.*

Source: Electric Power Statistics, Volume II, *Statistics Canada, Catalogue 57-202.*

Figure 5.1. Major generating stations by province, 1987 (MW)

Figure 5.2. Electricity generation by fuel type



stations in each province are shown in Figure 5.1.

Between 1960 and 1987, the share of hydro production dropped 27 percentage points, from 92 per cent to 65 per cent, as shown in Figure 5.2. The natural gas production share also decreased, from 4 per cent in 1960 to 1.5 per cent in 1987. The oil share has increased slightly, from 1 per cent to 1.8 per cent over the same period. Nuclear production had the largest gain, from zero in 1960 to 15 per cent by 1987, while the coal production share increased from 3 per cent in 1960 to about 17 per cent by 1987.

Electrical energy production by fuel type in 1987 is reported in Table 5.2. In Newfoundland, Quebec, Manitoba, British Columbia, and the Yukon Territory, hydro generation accounted for more than 94 per cent of the total. In Alberta, about 83 per cent of total generation came from coal-fired stations. Coal generation was also quite important in Saskatchewan and Nova Scotia, at 72 per cent and 70 per cent respectively.

Table 5.2. Electrical energy production by fuel type, 1987

	Coal	Oil	Natural Gas	Nuclear	Hydro	Total
			(GW.h)			
Newfoundland	0	2 317	0	0	37 773	40 090
Prince Edward Island	108	56	0	0	0	164
Nova Scotia	5 436	1 539	0	0	774	7 749
New Brunswick	1 452	3 710	0	5 112	2 219	12 493
Quebec	0	182	0	4 660	152 110	156 952
Ontario	32 291	47	1 524	63 116	34 604	131 582
Manitoba	577	7	7	0	19 311	19 902
Saskatchewan	8 931	12	309	0	3 188	12 440
Alberta	30 514	130	4 676	0	1 450	36 770
British Columbia	961	470	579	0	61 057	63 067
Yukon	0	24	0	0	409	432
Northwest Territories	0	172	0	0	294	467
Canada	80 270	8 666	7 095	72 888	313 189	482 108

Source: Energy, Mines and Resources Canada.

Ontario, Quebec, and New Brunswick are the only three provinces with nuclear energy in Canada. In 1987, nuclear generation accounted for 48 per cent of Ontario's total electricity generation, 41 per cent of New Brunswick's, and 3 per cent of Quebec's. Electricity generation from natural gas occurs mainly in industries that generate power for their own use. In all provinces except Newfoundland, Nova Scotia, and New Brunswick, oil is used mainly for peaking purposes.

GENERATION BY PROVINCE

Table 5.3 shows electricity generation by province during the period 1960-87, and generation growth rates for 1987 over 1986 and the period 1960-87. Newfoundland had the greatest production growth during the period 1960-87, with an average annual growth rate of 12.9 per cent. This was due mainly to the completion of the Churchill Falls hydro station (5429 MW) in Labrador in 1974.

Electricity generation fluctuated significantly in Prince Edward Island during the period 1960-87. The province's electrical generating plants are relatively small and are fuelled by oil, and are consequently expensive to operate. In 1977, an interprovincial interconnection was completed, allowing P.E.I. to purchase electrical energy from New Brunswick. In addition, in 1981 P.E.I. purchased a 10-per cent ownership interest in the 200-MW coal/oil-fired plant at Dalhousie, N.B. Because of the interconnection and joint ownership, P.E.I. has been able to reduce the amount of generation from its oil-fired stations.

In 1987, electricity generation in British Columbia increased by more than 24 per cent due to export sales to the United States. Meanwhile, Manitoba experienced a 17.3 per cent drop in total generation because of poor water conditions in the province.

Figure 5.3 presents electricity generation by region. Although Quebec has been the largest electricity producer in Canada since 1960, its share has declined from 44 per cent of the total in 1960 to about 33 per cent by 1987; Ontario was second with 27 per cent in 1987, compared with 31 per cent in 1960; and British Columbia was third with 13 per cent in 1987, slightly greater than the 12 per cent registered in 1960.

FOSSIL-FUEL REQUIREMENTS

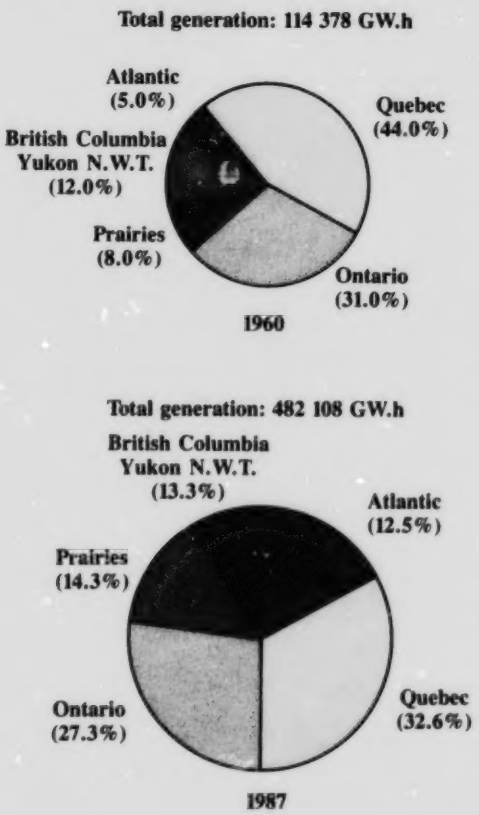
Table 5.4 reports fuel use during the period 1960-87. Because of the rapid expansion of coal-fired stations in the 1960s and 1970s, coal consumption increased about nine times during the period 1960-75, and more than doubled during the following ten years. However, coal used to generate electricity has fluctuated recently: 40 million tonnes in 1985; 38 million tonnes in 1986; and 43 million tonnes in 1987. The largest increase in coal use in 1987 occurred in Ontario. The use of natural gas and oil for electricity generation peaked in the mid-1970s and early 1980s, and then declined substantially. The increased use of oil and natural gas for electricity generation in 1987

Table 5.3. Sources of electricity by province

	Electricity Generation								Average annual growth rate			
	1960	1965	1970	1975	1980	1985	1986	1987	1960-74	1975-87	1960-87	1986-87
	(GW.h)								(per cent)			
Nfld.	1 512	2 769	4 854	35 803	46 374	41 494	40 407	40 090	23.4	1.0	12.9	-0.8
P.E.I.	79	137	250	421	127	2	151	164	11.9	-7.6	2.7	8.6
N.S.	1 814	2 632	3 511	5 498	6 868	7 457	7 401	7 749	8.2	2.9	5.5	4.7
N.B.	1 738	2 960	5 142	4 677	9 323	11 401	12 057	12 493	8.7	8.5	7.6	3.6
Quebec	50 433	57 005	75 877	76 108	97 917	137 028	148 261	156 952	3.7	6.2	4.3	5.9
Ontario	35 815	44 858	63 857	78 558	110 283	121 783	125 195	131 582	6.2	4.4	4.9	5.1
Manitoba	3 742	5 489	8 449	14 818	19 468	22 777	24 054	19 902	10.2	2.5	6.4	-17.3
Sask.	2 204	3 733	6 011	7 090	9 204	11 838	11 913	12 440	9.0	4.8	6.6	4.4
Alberta	3 443	5 591	10 035	15 100	23 451	33 432	34 719	36 770	10.8	7.7	9.2	5.9
B.C.	13 409	18 832	26 209	34 542	43 416	59 124	50 758	63 067	7.4	5.1	5.9	24.3
Yukon	89	121	224	352	381	252	344	432	9.3	1.7	6.0	25.6
N.W.T.	100	147	304	425	494	594	535	467	10.2	0.8	5.9	-12.7
Canada	114 378	144 274	204 723	273 392	367 306	447 182	455 795	482 108	6.6	4.8	5.5	5.8

Source: Electric Power Statistics, Volume II, *Statistics Canada, Catalogue 57-202.*

Figure 5.3. Electricity generation by region



can be attributed mainly to the collapse of world oil prices. The use of uranium has increased dramatically since 1970 with the growth of nuclear capacity in Canada.

Electricity generated from conventional thermal and nuclear sources totalled about 168 919 GW.h in 1987, or about 35 per cent of total generation. In terms of heat content, fuels used for this generation amounted to the equivalent of 291 million barrels of oil. A breakdown of the fuels used by utilities is provided in Table 5.5. Ontario was the largest user, accounting for approximately 50 per cent of the total. Alberta was second, accounting for 27 per cent, and Saskatchewan ranked third with a 10-per cent share.

New Brunswick remained the largest user of oil, followed by Newfoundland and Nova Scotia. All three provinces are still using oil for base-load generation.

Alberta is the largest user of coal for electricity generation, accounting for 43 per cent of the coal used in Canada for electricity generation.

Energy sources of electricity generation changed significantly in 1987 from the previous year. The

Table 5.4. Fuels used to generate electricity in Canada

	1960	1965	1970	1975	1980	1985	1986	1987
Coal (10^3 tonnes)	1 674	7 004	13 786	16 567	27 785	39 456	37 562	42 500
Oil (10^3 cubic metres)	328	871	1 869	2 309	2 867	1 391	1 301	2 054
Natural gas (10^6 cubic metres)	1 069	1 679	1 992	4 009	1 875	1 223	2 571	2 979
Uranium (tonnes)	0	2	16	194	685	1 086	1 276	1 306

Source: Electric Power Statistics, Volume II, *Statistics Canada, Catalogue 57-202.*

Table 5.5. Fossil fuels used by utilities, 1987

	Coal (10^3 tonnes)	Oil (cubic metres)	Gas (10^6 cubic metres)	Uranium (tonnes)
Nfld.	0	595 002	0	0
P.E.I.	46	25 900	0	0
N.S.	2 225	343 044	0	0
N.B.	526	885 103	0	99
Que.	0	74 928	0	87
Ont.	13 373	57 203	923	1 120
Man.	457	349	6	0
Sask.	7 672	2 401	91	0
Alta.	18 201	31	1 850	0
B.C.	0	61	98	0
N.W.T.	0	1 005	11	0
Yukon	0	8 873	0	0
Canada	42 500	2 053 905	2 979	1 306

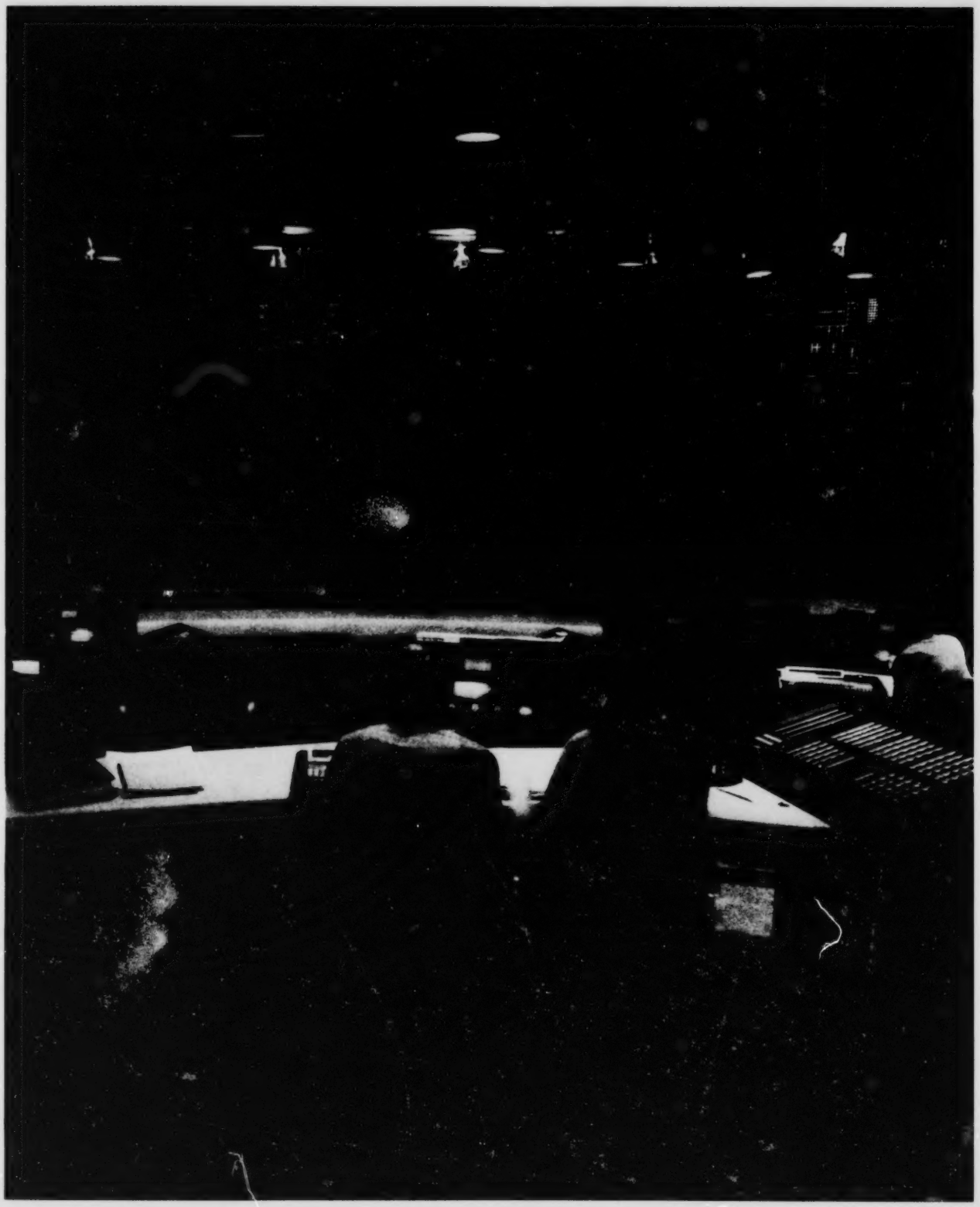
Note: 1 cubic metre oil = 6.3 barrels
1 cubic metre gas = 35.5 cubic feet
1 tonne = 1000 kilograms

Source: Energy, Mines and Resources Canada.

increase in coal use, from 38 million tonnes in 1986 to about 43 million tonnes in 1987, is attributed mainly to a 32 per cent increase in coal-fired generation in Ontario.
Oil use also increased, up from 8.2 million barrels in 1986 to 12.9 million barrels in 1987. Most of this increase occurred in Newfoundland, Nova Scotia, and New Brunswick. The collapse of world oil prices in 1987 provided an economic incentive for these three provinces to use more oil-fired stations for electricity generation.
Uranium use increased with the addition of Ontario's Bruce 8 station, and the return to service of the Pickering 1 nuclear reactor, following a shutdown for retubing.
Natural gas use increased moderately, with most of the increase occurring in Ontario and Alberta.

In 1987, provinces west of Quebec continued to use Canadian oil, primarily light oil and diesel oil, in gas turbines or diesel plants. In the Yukon and Northwest Territories, Canadian diesel oil was used to supply electricity to small remote communities. Oil used by the Atlantic region and Quebec was imported.

In 1987, about 65 per cent of the coal used for electricity generation in Ontario was imported from the United States, while the remainder came from western Canada. Coal used by Manitoba was purchased from Saskatchewan, while Alberta, Nova Scotia, and New Brunswick used their own coal resources. Saskatchewan relied primarily on its own coal, but also purchased additional amounts from Alberta.



Hydro-Québec's system control centre in Montreal is the core of its operations, ensuring effective management of the utility's vast grid.

6. Generating Capacity and Reserve

In 1987, more than half of Canada's installed generating capacity was hydro. Conventional thermal (coal, oil, and natural gas) constituted a further 30.7 per cent, while nuclear supplied the remaining 11.9 per cent.

Table 6.1 reports installed generating capacity by fuel type for Canada during the period 1960-87. Figure 6.1 illustrates the change in Canada's installed capacity by principal fuel type between 1960 and 1987.

The most significant change in the 1960-87 period has been the decline in the relative share of hydro capacity, from 81 per cent in 1960 to 57.4 per cent in 1987. The decline in hydro's share has been matched by an increase in the share taken by coal (from 9.0 per cent to 17.8 per cent) and nuclear (zero to 11.9 per cent). The share taken by oil and natural gas has not changed significantly over the period.

CAPACITY ADDITIONS

Because most electric utilities in Canada currently have surplus capacity, there was only one major capacity addition in 1987. On May 22, 1987, the eighth and final unit at the Bruce nuclear power

Figure 6.1. Installed generating capacity by fuel type

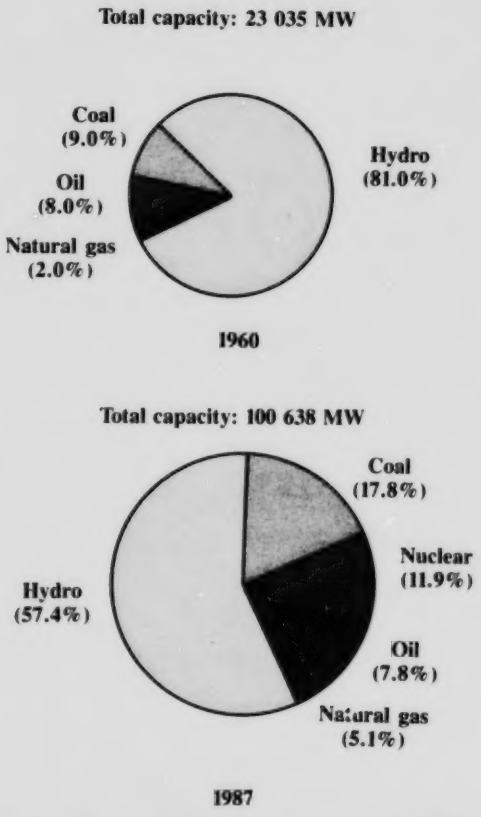


Table 6.1. Installed generating capacity by fuel type, 1960-1987

Fuel Type	Installed Generating Capacity								Average annual growth rate			
	1960	1965	1970	1975	1980	1985	1986	1987	1960-74	1975-87	1960-87	1986-87
	(MW)								(per cent)			
Hydro	18 643	21 771	28 298	37 282	47 770	57 711	57 711	57 711	5.0	3.7	4.3	0.0
Thermal	4 392	7 557	14 287	21 404	28 363	30 476	30 980	30 979	11.7	3.2	7.5	0.0
*Nuclear**	0	20	240	2 666	5 866	10 664	11 098	11 928	-	12.8	-	7.5
*Tidal***	0	0	0	0	0	20	20	20	-	-	-	0.0
Total	23 035	29 348	42 826	61 352	81 999	97 020	99 809	100 638	6.8	4.2	5.6	0.8

* *Commercial operation started in 1968.*
** *Commercial operation started in 1984.*

Source: Electric Power Statistics, Volume II, *Statistics Canada, Catalogue 57-202.*

development in Ontario was declared in-service. The 837-MW reactor brings the total capacity of the Bruce generating complex to 6402 MW.

CAPACITY BY FUEL TYPE AND PROVINCE

Total installed capacity by principal fuel type and province for 1987 is given in Table 6.2. Installed capacity by region from 1960 to 1987 is shown in Figure 6.2. Figure 6.2 indicates that in 1960 Quebec's installed capacity was the largest in Canada, with 39 per cent of the total, followed by Ontario with 31 per cent, and British Columbia with 13 per cent. In 1987, Quebec was in second place, behind Ontario. Quebec's capacity share was 27.5 per cent in 1987, while Ontario's share was 32 per cent. The Atlantic provinces had the major gain; their share increased from 5 per cent in 1960 to 13.3 per cent by 1987. The increase was due largely to the completion of the Churchill Falls project in 1974, which added significantly to Newfoundland's installed capacity.

Figure 6.2. Installed generating capacity by region

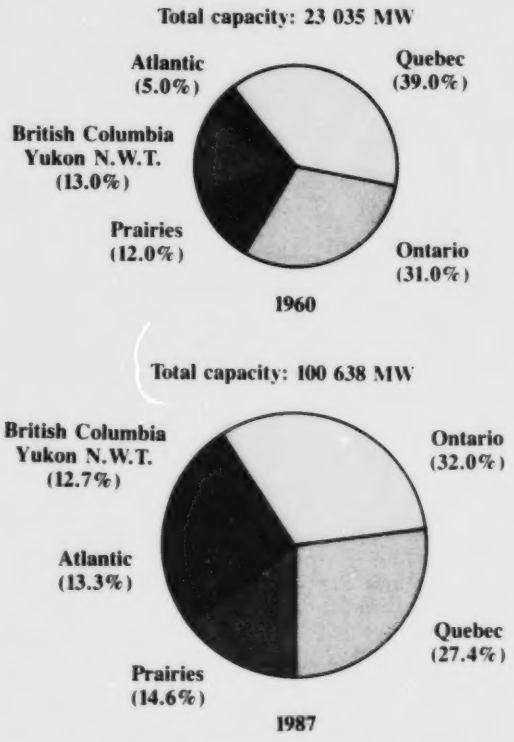


Table 6.2. Installed generating capacity by fuel type and province, 1987

	Hydro	Coal	Nuclear	Oil	Natural Gas	Total
			(MW)			
Nfld.	6 644	0	0	758	0	7 402
P.E.I.	0	20	0	102	0	122
N.S.	386	954	0	1 006	0	2 346
N.B.	903	307	680	1 600	0	3 490
Que.	25 849	0	685	1 110	0	27 644
Ont.	7 764	9 600	10 563	2 673	1 523	32 123
Man.	3 641	442	0	50	4	4 137
Sask.	830	1 815	0	7	296	2 948
Alta.	734	4 586	0	80	2 205	7 605
B.C.	10 848	0	0	551	1 109	12 508
Yukon	82	0	0	41	0	123
N.W.T.	50	0	0	120	20	190
Canada	57 731	17 724	11 928	8 098	5 157	100 638

Source: Electric Power Statistics, Volume II, *Statistics Canada, Catalogue 57-204. Energy, Mines and Resources Canada.*

Table 6.3 presents total installed capacity by province during the period 1960-87, along with a comparison of the annual growth rates for the various periods. As with energy generation, capacity growth during the period 1960-74 was substantially larger than for the period 1975-87. For Canada as a whole, the growth rate for capacity before the first oil crisis was much larger than that after the oil crisis. For the period 1960-87, Newfoundland had the largest capacity growth rate with 12.4 per cent, followed by New Brunswick with 8.3 per cent, and Alberta with 8.2 per cent. Quebec had the smallest growth rate for installed capacity during the same period, with 4.3 per cent.

MAJOR HYDRO PLANTS IN CANADA

Table 6.4 reports the ten hydro plants in Canada with the largest capacity in 1987. Churchill Falls was the largest hydro station with 5429 MW, followed by La Grande 2 with 5328 MW, and La Grande 4 with 2651 MW. Five of the ten hydro plants are located in Quebec, three in British Columbia, and one each in Newfoundland and Ontario. These ten hydro stations have a total installed capacity of 25 926 MW, and they accounted for about 45 per cent of Canada's total hydro capacity in 1987.

MAJOR CONVENTIONAL THERMAL STATIONS IN CANADA

The ten largest thermal stations are given in Table 6.5. The largest thermal plant in 1987 was the Nanticoke coal-fired station with 4096 MW, followed by Lakeview with 2400 MW, and Lennox with 2295 MW. Seven of the ten stations are using coal as input fuel, two oil, and one natural gas. Five of the ten largest thermal stations are located in Ontario; two are in Alberta; and there is one each in New Brunswick, Saskatchewan, and British Columbia. Total combined capacity for these stations is 17 834 MW, which accounted for 58 per cent of Canada's total conventional thermal installed capacity in 1987.

NUCLEAR POWER IN CANADA

By the end of 1987, there were 18 commercial nuclear power stations in Canada. With the exception of Point Lepreau I in New Brunswick and Gentilly 2 in Quebec, they are all located in Ontario. Table 6.6 reports major nuclear power stations in Canada in order of their commissioning date. Total installed capacity for these nuclear power stations is 11 799 MW, which accounted for 12 per cent of Canada's total installed capacity in 1987.

SURPLUS CAPACITY

As indicated in Table 4.1, there have been two distinct periods in the growth of electricity demand in Canada between 1960 and 1987. From 1960 to 1974, there was a period of rapid growth, with an average annual increase of 6.6 per cent. Following the oil crisis of 1973-74, electricity growth slowed to an average rate of 4.1 per cent for the period 1975-87. Electricity consumption actually declined in 1975 and did not grow in 1982.

Table 6.3. Installed generating capacity by province, 1960-1987

	Installed Generating Capacity								Average Annual Growth Rate			
	1960	1965	1970	1975	1980	1985	1986	1987	1960-74	1975-87	1960-87	1986-87
	(MW)								(per cent)			
Nfld.	314	531	1 248	6 668	7 195	7 316	7 402	7 402	21.4	0.9	12.4	0.0
P.E.I.	37	58	77	118	118	122	122	122	8.6	0.3	4.5	0.0
N.S.	507	631	931	1 263	2 029	2 373	2 346	2 346	6.4	5.3	5.8	0.0
N.B.	402	581	1 201	1 333	2 795	3 479	3 490	3 490	8.9	8.4	8.3	0.0
Quebec	8 920	10 769	14 047	15 037	20 531	26 991	27 644	27 644	3.7	5.2	4.3	0.0
Ontario	7 109	9 292	13 700	21 136	25 796	29 932	31 294	32 123	7.0	3.6	5.7	2.7
Manitoba	1 043	1 407	1 794	2 970	4 142	4 141	4 137	4 137	7.8	2.8	5.2	0.0
Sask.	761	967	1 533	1 833	2 340	2 694	2 948	2 948	6.2	4.0	5.1	0.0
Alberta	915	1 398	2 674	3 585	5 807	7 219	7 605	7 605	9.9	6.5	8.2	0.0
B.C.	2 963	3 627	5 473	7 170	10 525	12 451	12 508	12 508	6.0	4.8	5.5	0.0
Yukon	31	56	58	102	94	123	123	123	5.6	1.6	5.2	0.0
N.W.T.	33	51	89	136	180	177	190	190	9.3	2.8	6.7	0.0
Canada	23 035	29 348	42 826	61 352	81 999	97 019	99 809	100 638	6.8	4.2	5.6	0.8

Source: Electric Power Statistics, Volume II, *Statistics Canada, Catalogue 57-202.*

Table 6.4. Canada's largest hydro stations, 1987

Rank	Name	Province	Rated Capacity (MW)	Year of Initial Operation
1	Churchill Falls	Newfoundland	5 429	1971
2	La Grande 2	Quebec	5 328	1979
3	La Grande 4	Quebec	2 651	1984
4	Gordon M. Schrum	B.C.	2 416	1979
5	La Grande 3	Quebec	2 302	1982
6	Revelstoke	B.C.	1 843	1984
7	Mica	B.C.	1 736	1976
8	Beauharnois	Quebec	1 639	1932
9	Manic 5	Quebec	1 292	1970
10	Sir Adam Beck 2	Ontario	1 288	1954

Source: Electric Power Statistics, Volume III, *Statistics Canada, Catalogue 57-206, 1986.*

Table 6.5. Canada's largest conventional thermal stations, 1987

Rank	Name	Fuel Type	Province	Rated Capacity (MW)	Year of Initial Operation
1	Nanticoke	coal	Ontario	4 096	1973
2	Lakeview	coal	Ontario	2 400	1962
3	Lennox	oil	Ontario	2 295	1976
4	Sundance	coal	Alberta	2 200	1970
5	Lambton	coal	Ontario	2 000	1969
6	Richard L. Hearn	coal	Ontario	1 200	1951
7	Coleson Cove	oil	N.B.	1 050	1976
8	Burrard	natural gas	B.C.	913	1962
9	Boundary Dam	coal	Saskatchewan	874	1959
10	Keephills	coal	Alberta	806	1983

Source: Electric Power Statistics, Volume III, *Statistics Canada, Catalogue 57-206, 1986.*

This shift, from a long period of sustained rapid growth to one of slower growth, resulted in excess generating capacity. In the early 1970s, the construction of new generating stations was initiated mainly on the basis of expectations of continuing rapid growth in electricity demand, but also to displace oil-fuelled electricity production. As the growth in demand slowed dramatically in the latter part of the decade, some of these newly constructed stations became surplus to domestic requirements.

In calculating surplus capacity, the net generating capability, rather than net generating capacity, is normally used. Net generating capability measures the expected power of all available generating facilities of the province (or country) at the time of one hour firm peak load. This may differ from the generating capacity measured by the nameplate rating of the equipment (see Table 6.1).

Differences between generating capability and generating capacity may be caused by a number of factors. These include the water levels in reservoirs, the fact that not all equipment can be placed on line at the same time, and the fact that some equipment may be out of service for one reason or another.

RESERVE MARGINS

The reserve margin of an electrical system is defined as the excess of net generating capability for in-province use over the in-province firm peak that occurred during the year, expressed as a percentage of in-province firm peak. Column 4 of Table 6.7 presents the reserve margin in the provinces and territories in 1987. Newfoundland had the largest reserve with 91 per cent, followed by the Yukon with 78 per cent, the Northwest Territories with 68 per cent, Prince Edward Island with 54 per cent, and British Columbia with 51 per cent. The reserve margin for Canada as a whole was 32 per cent.

Table 6.8 summarizes reserve margin percentages for the period 1960-87. In general, margins have steadily increased since 1960.

Table 6.6. Commercial nuclear power plants in Canada, 1987

	Plant Name	Province	Rated Net Capacity (MW)	Commissioning Date
1	Pickering A1	Ontario	515	1971
2	Pickering A2	Ontario	515	1971
3	Pickering A3	Ontario	515	1972
4	Pickering A4	Ontario	515	1973
5	Bruce A1	Ontario	759	1977
6	Bruce A2	Ontario	769	1977
7	Bruce A3	Ontario	759	1978
8	Bruce A4	Ontario	769	1979
9	Point Lepreau 1	New Brunswick	635	1983
10	Pickering B5	Ontario	516	1983
11	Gentilly 2	Quebec	638	1983
12	Pickering B6	Ontario	516	1984
13	Bruce B6	Ontario	837	1984
14	Pickering B7	Ontario	516	1985
15	Bruce B5	Ontario	835	1985
16	Pickering B8	Ontario	516	1986
17	Bruce B7	Ontario	837	1986
18	Bruce B8	Ontario	837	1987

Source: Uranium and Nuclear Energy Branch, Energy, Mines and Resources Canada.

Table 6.7. Surplus capacity, 1987

	Net Generating Capability for In-Province Use (MW) (1)	In-Province Firm peak (MW) (2)	Reserve Margin (MW) (3) = (1)-(2)	Percentage of Reserve (4) = (3)/(2)
Newfoundland	2 995	1 570	1 425	91
P.E.I.	140	91	49	54
Nova Scotia	2 019	1 445	574	40
New Brunswick	3 040	2 210	830	38
Quebec	31 266	25 885	5 381	21
Ontario	27 915	21 442	6 473	30
Manitoba	4 286	2 992	1 294	43
Saskatchewan	2 694	2 126	568	27
Alberta	7 387	5 207	2 180	42
B.C.	12 499	8 271	4 228	51
Yukon	121	68	53	78
N.W.T.	186	111	75	68
Canada	94 532	71 418	23 114	32

Source: Electric Power Statistics, Volume I, *Statistics Canada, Catalogue 57-204.*

Table 6.8. Surplus capacity percentages, 1960-1987

	1960	1965	1970	1975	1980	1985	1986	1987
				(per cent)				
Nfld.	20	17	55	48	98	101	79	91
P.E.I.	81	66	33	33	13	40	42	54
N.S.	39	32	13	18	62	38	38	40
N.B.	17	9	49	34	33	51	41	38
Que.	37	16	16	10	14	20	20	21
Ont.	14	6	13	26	34	11	12	30
Man.	32	41	24	18	54	48	47	43
Sask.	60	28	26	30	7	15	26	27
Alta.	30	23	38	32	45	36	46	42
B.C.	43	19	23	30	49	50	60	51
Yukon	42	100	23	58	29	130	72	78
N.W.T.	87	48	42	46	51	70	85	68
Canada	28	15	19	25	31	26	30	32

Source: Calculated from Electric Power Statistics, Volume I, *Statistics Canada, Catalogue 57-204.*

7. Electricity Trade

INTERNATIONAL TRADE

Electricity trade between Canada and the United States dates back to the beginning of the century. In 1901, the first electric power transmission line (12 000 volts) was built across the border at Niagara Falls. This early interconnection enabled Canada to market its abundant hydroelectric power in the United States. For most of the century, electricity trade between Canada and the United States was balanced. However, between the early 1970s and 1987, Canada's net exports to the United States grew steadily in both quantity and revenue. Electricity trade statistics for the period 1960-87 are summarized in Table 7.1.

In 1987, electricity exports to the United States (excluding non-cash service exchanges) were 45 359 GW.h, an increase of 29 per cent from 1986. The higher export volumes are mainly attributable to increased sales by B.C. Hydro and new sales by Hydro-Québec to the New England area. Electricity exports in 1987 accounted for 9.4 per cent of Canada's total generation, up from 7.7 per cent in 1986.

Export revenues increased 12 per cent in 1987 to $1.211 billion, compared to $1.086 billion in 1986. Electricity imports from the United States in 1987 were 536 GW.h, and import costs to Canada were about

Table 7.1. Canada-U.S. electricity trade, 1960-1987

	Exports* (GW.h) (1)	Exports as a percentage of net generation (2)	Export revenues ($ million) (3)	Imports* (GW.h) (4)	Imports as a percentage of total disposal (5)	Import costs ($ million) (6)	Net Exports	
							GW.h (7) = (1)-(4)	$ Million (8) = (3)-(6)
1960	5 496	4.8	14	357	0.3	1	5 139	13
1961	4 158	3.7	10	1 394	1.3	2	2 764	8
1962	4 112	3.5	8	2 779	2.4	3	1 333	5
1963	3 613	3.0	7	2 884	2.4	3	729	4
1964	4 159	3.1	10	3 121	2.3	3	1 038	7
1965	3 684	2.6	8	3 575	2.5	3	109	5
1966	4 397	2.8	8	3 218	2.1	3	1 179	5
1967	3 994	2.4	8	4 181	2.6	6	-187	2
1968	3 988	2.1	8	4 129	2.3	6	-141	2
1969	4 320	2.3	15	2 740	1.5	3	1 580	12
1970	5 631	2.8	32	3 245	1.6	9	2 386	23
1971	7 321	3.4	45	3 378	1.6	8	3 943	37
1972	11 037	4.6	66	2 381	1.0	3	8 656	63
1973	16 286	6.2	115	2 249	0.9	1	14 037	114
1974	15 400	5.5	169	2 441	0.9	1	12 959	168
1975	11 409	4.2	105	3 972	1.5	3	7 819	102
1976	12 804	4.4	174	3 590	1.3	7	9 214	167
1977	19 957	6.3	419	2 690	0.9	13	17 267	406
1978	20 437	6.1	479	170	0.1	2	20 267	477
1979	30 458	8.6	739	24	0.0	1	30 434	738
1980	28 224	7.7	794	168	0.1	3	28 056	791
1981	34 730	9.1	1 144	466	0.1	5	34 264	1 138
1982	32 986	8.8	1 107	257	0.1	5	32 729	1 102
1983	37 258	9.4	1 249	239	0.1	6	37 019	1 243
1984	37 563	8.8	1 355	290	0.1	10	37 272	1 345
1985	41 441	9.3	1 425	231	0.1	9	41 210	1 416
1986	35 271	7.7	1 086	343	0.1	9	34 928	1 077
1987	45 359	9.4	1 211	536	0.1	12	44 823	1 199

** Exports and imports prior to 1977 include service exchanges.*

Source: Electric Power Statistics, Volume II, *Catalogue 57-202, Statistics Canada. Energy, Mines and Resources Canada.*

$12 million, up slightly from the previous year.

Electricity exports to the United States by type of energy transaction during the period 1960-87 are presented in Table 7.2. In the past 28 years, firm exports[1] fluctuated between 14 and 31 per cent, and interruptible exports[2] ranged from 69 to 86 per cent. In 1987, approximately 81 per cent of the electricity exported was interruptible, up from 72 per cent in 1986. The revenue share of interruptible exports was 71 per cent in 1987, compared with 56 per cent in 1985.

Average export revenues for the period 1960-87 are reported in Table 7.3. The table illustrates the fact that firm exports are normally more valuable than interruptible exports. This has been the case in all years except 1974-75 and 1979-81.

Table 7.2. Electricity exports to the United States by type, 1960-1987

	Quantity (GW.h)		Revenue ($1000)		Quantity share (%)		Revenue share (%)	
	Firm	Interruptible	Firm	Interruptible	Firm	Interruptible	Firm	Interruptible
1960	1 040	4 456	4 328	10 023	19	81	30	70
1961	1 192	2 965	5 769	3 783	29	71	60	40
1962	1 261	2 851	6 487	1 775	31	69	79	21
1963	882	2 730	4 625	2 028	24	76	70	30
1964	871	3 289	5 561	4 359	21	79	56	44
1965	635	3 049	4 261	3 322	17	83	56	44
1966	614	3 783	4 257	3 402	14	86	56	44
1967	705	3 289	4 663	3 068	18	82	60	40
1968	741	3 247	5 003	2 714	19	81	65	35
1969	838	3 482	5 735	9 279	19	81	38	62
1970	984	4 648	6 828	25 309	18	82	21	79
1971	1 860	5 461	13 270	31 951	25	75	29	71
1972	2 047	8 990	19 198	46 846	19	81	29	71
1973	2 637	13 649	19 891	94 947	16	84	17	83
1974	2 488	12 912	20 939	147 945	16	84	12	88
1975	2 375	9 034	20 382	84 488	21	79	19	81
1976	2 061	10 743	39 010	134 755	16	84	22	78
1977	3 727	15 230	90 220	329 050	19	81	22	78
1978	3 980	16 457	94 543	384 011	20	80	20	80
1979	6 692	23 766	135 763	602 740	22	78	18	82
1980	7 232	20 992	156 731	636 760	26	74	20	80
1981	5 008	29 722	105 116	1 038 761	14	86	9	91
1982	5 831	27 154	243 140	863 558	18	82	22	78
1983	10 569	26 689	445 751	802 806	28	72	36	64
1984	10 852	26 711	491 662	863 057	29	71	36	64
1985	12 305	29 136	547 109	877 657	30	70	38	62
1986	9 756	25 515	480 767	605 258	28	72	44	56
1987	8 840	36 519	354 781	856 068	19	81	29	71

Source: Electric Power Statistics, Volume II, *Catalogue 57-202, Statistics Canada, Energy, Mines and Resources Canada.*

[1] In firm export transactions, the exporting utility guarantees the delivery of energy or capacity over a scheduled period of time.

[2] Interruptible export transactions are sales of energy and/or power from surplus generating resources. There is no guarantee of delivery and interruptible exports can be curtailed by the seller on very short notice.

Average firm export revenues dropped 19 per cent to 40.1 mills per kW.h in 1987, from 49.3 mills per kW.h in 1986. Average interruptible export revenues declined by 1.3 per cent, from 23.7 mills per kW.h in 1986 to 23.4 mills per kW.h in 1987.

Table 7.4 summarizes the generating sources of electricity exports to the United States during the period 1975-87. Hydro-generated electricity continued to be the main source of Canada's electricity exports, accounting for more than 75 per cent of the total exported in 1987, up from 73 per cent in 1986.

Provincial sources of exports, revenues, and average revenues received in 1986 and 1987 are reported in Table 7.5. Quebec, Ontario, and British Columbia showed increases in the quantity of electricity exported in 1987, while Manitoba, Saskatchewan, and New Brunswick showed decreases. The largest decrease occurred in Manitoba, as a result of low water conditions in the province.

The average revenue received from electricity exports in 1987 varied significantly from province to province. New Brunswick received

Table 7.3. Average export revenues, 1960-1987

Year	Firm	Interruptible	Total
	(mills/kW.h)		
1960	4.2	2.3	2.6
1961	4.8	1.3	2.3
1962	5.1	0.6	2.0
1963	5.2	0.7	1.8
1964	6.4	0.9	2.4
1965	6.7	1.1	2.1
1966	6.9	0.9	1.7
1967	6.6	0.9	1.9
1968	6.8	0.8	1.9
1969	6.8	2.7	3.5
1970	6.9	5.5	5.7
1971	7.1	5.9	6.2
1972	9.4	5.2	6.0
1973	7.5	7.0	7.1
1974	8.4	11.5	11.0
1975	8.6	9.4	9.2
1976	18.9	12.5	13.6
1977	24.2	20.3	21.0
1978	23.8	23.3	23.4
1979	20.3	25.4	24.3
1980	21.7	30.3	28.1
1981	21.0	34.9	32.9
1982	41.7	31.8	33.6
1983	42.?	30.1	33.5
1984	45.3	32.3	36.1
1985	44.5	30.1	34.4
1986	49.3	23.7	30.8
1987	40.1	23.4	26.7

Source: Calculated from Electric Power in Canada, 1987, *Table 7.2.*

Table 7.4. Generation sources of Canadian exports, 1975-1987

	Hydro	Imported Coal	Imported Oil	Domestic Coal/Oil	Nuclear	Total
1975	5 724	4 838	494	353	0	11 409
1976	6 973	4 323	1 206	302	0	12 804
1977	7 926	8 514	2 961	555	0	19 957
1978	7 290	10 476	2 260	411	0	20 437
1979	15 213	11 587	3 354	128	177	30 458
1980	14 135	10 599	2 867	593	30	28 224
1981	21 182	10 901	1 940	665	42	34 730
1982	20 114	10 315	1 959	502	96	32 986
1983	21 978	11 704	1 201	519	1 856	37 258
1984	22 807	10 582	1 552	711	1 911	37 563
1985	28 836	8 245	1 157	956	2 247	41 441
1986	25 727	5 389	846	825	2 484	35 271
1987	34 065	7 575	1 270	408	2 041	45 359

Source: Compiled from National Energy Board statistics.

Table 7.5. Electricity exports and revenues by province, 1986-1987*

	Quantity (GW.h)			Revenue (million $)			Average Revenue (mills/kW.h)		
	1986	1987	% Change	1986	1987	% Change	1986	1987	% Change
N.B.	6 652	5 910	11	278.8	278.0	0	47.9	47.1	12
Que.	12 640	16 400	30	378.3	445.4	18	29.9	27.2	-9
Ont.	6 757	7 194	7	270.3	215.6	-20	40.0	30.0	-25
Man.	7 009	3 314	-53	111.7	65.3	-42	16.0	19.7	23
Sask.	110	55	-50	1.1	0.2	-82	10.6	3.1	-71
B.C.	2 103	12 486	494	45.5	206.4	254	21.7	16.5	-24
Canada	35 271	45 359	29	1 086.0	1 210.9	12	30.8	26.7	-13

** Excludes non-cash exchanges.*

Source: National Energy Board.

the highest average revenue, 47.1 mills per kW.h, while Saskatchewan received the lowest, 3.1 mills per kW.h. This variance reflects differences in the product exported, the cost of generation, and the alternatives available in the export market.

As indicated in Table 7.5, average revenues for most of the exporting provinces fell in 1987. The low international price of crude oil was the main factor contributing to lower average revenues. As mentioned above, more than 81 per cent of electricity exports to the United States in 1987 were interruptible sales, which are largely priced in relation to the importing utility's marginal cost of oil-fired generation. Lower world oil prices mean lower U.S. generation costs which, in turn, reduce Canada's export prices. For Canada as a whole, average export revenue dropped by 13 per cent in 1987.

Table 7.6 presents the proportion of firm and interruptible electricity exports for the six exporting provinces. While firm exports accounted for just 19 per cent of total Canadian electricity exports in 1987, the proportion of firm exports

Table 7.6. Firm and interruptible exports, 1987*

	Firm	Interruptible	Firm	Interruptible
	(GW.h)		(per cent)	
New Brunswick	2 319	3 590	39	61
Quebec	5 264	11 137	32	68
Ontario	265	6 929	4	96
Manitoba	501	2 813	15	85
Saskatchewan	44	11	80	20
British Columbia	447	12 039	4	96
Canada	8 840	36 519	19	81

** Exchanges are excluded.*

Source: National Energy Board.

Table 7.7. Energy sources of electricity exports, 1987

	Oil	Coal	Nuclear	Hydro	Total
			(per cent)		
New Brunswick	22.5	11.0	34.3	32.2	100
Quebec	-	-	-	100.0	100
Ontario	-	98.3	1.0	0.7	100
Manitoba	-	17.5	-	82.5	100
Saskatchewan	-	100.0	-	-	100
British Columbia	-	-	-	100.0	100
Canada	2.8	16.7	4.5	75.1	100

Source: Energy, Mines and Resources Canada.

ranged from 4 per cent in Ontario and British Columbia, to about 80 per cent in Saskatchewan.

Table 7.7 reports the provincial energy sources of electricity exported during 1987. Exports from Quebec and British Columbia were generated entirely from hydroelectric stations. Manitoba's exports also overwhelmingly came from hydro. Exports from Saskatchewan were generated entirely from indigenous coal, while Ontario's exports came primarily from thermal stations using imported coal. Nuclear-generated power for export decreased in Ontario, from 2.5 per cent in 1986 to 1.0 per cent in 1987. In New Brunswick, electricity exports were generated from nuclear, oil, and coal sources. The hydro-based electricity exported by New Brunswick was purchased from Quebec and not generated within the province. New Brunswick was the only province using base-load oil-fired generation for exports.

Export markets in the U.S. are summarized in Table 7.8. New York State was the most important market for Canadian electricity exports. Of the total 45 359 GW.h exported in 1987, New York received about 15 832 GW.h, or 35 per cent. New York accounted for 35 per cent of Canada's total $1.211 billion export revenue.

The New England states were also an important market for Canadian electricity exports in 1987. They imported 12 861 GW.h from New Brunswick, Quebec, and Ontario, accounting for 28 per cent of total Canadian electricity exports. New England contributed $495 million, or 41 per cent of Canada's total export revenue.

Canadian electricity exports, as a percentage of total electrical energy demand in the United States, increased from 1.4 per cent in 1986 to 1.8 per cent in 1987. However, the dependence of the U.S. on

Table 7.8. Exporting provinces and importing markets, 1987

Exporting Province	Importing Market	Quantity (MW.h)	Value ($1000)
New Brunswick	Maine	4 096 147	157 602
	Massachusetts	1 813 437	120 432
Quebec	Maine	947	47
	New Hampshire	17	1
	Vermont	1 914 164	70 648
	New England	4 772 999	136 241
	New York	9 712 113	238 409
Ontario	New York	6 119 645	182 594
	Michigan	808 226	22 459
	Minnesota	2 850	118
	Vermont	263 524	10 400
Manitoba	Minnesota	2 561 070	50 966
	North Dakota	753 052	14 342
Saskatchewan	North Dakota	54 960	168
British Columbia	Washington	1 681 905	30 295
	Oregon	4 656 834	65 663
	Idaho	41 132	681
	Montana	28 083	405
	California	6 020 559	108 517
	Nevada	19 539	277
	Utah	37 146	520
	Alaska	423	63
Canada	United States	45 358 776	1 210 848

Source: National Energy Board.

Canadian exports was higher in certain regions. Exports to New York accounted for 12 per cent of the state's total electricity consumption in 1987. The corresponding ratio was 13 per cent for New England, 3 per cent for the Midwest, and 3 per cent for the Pacific Northwest and California.

Provincial shares of total Canadian electricity exports are shown in Table 7.9. Quebec was the leading exporter in 1987, followed by British Columbia and Ontario.

ELECTRICITY TRADE AND THE ECONOMY

The export of electricity is an important aspect of Canada's foreign trade. Although total electricity export revenue accounted for only 1.0 per cent of total merchandise exports in 1987, Figure 7.1 shows that net electricity export revenue contributed 13 per cent of the total $8.97 billion merchandise trade balance in the same year.

Canadian energy trade by fuel type during the period 1978-87 is reported in Table 7.10. In 1987, total electricity export revenue

Table 7.9. Provincial shares of Canadian electricity exports, 1960-1987

Year	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	British Columbia	Canada
1960	3.0	10.4	86.6	0.0	0.0	0.0	100.0
1961	4.9	9.8	84.8	0.0	0.0	0.5	100.0
1962	6.0	7.2	86.4	0.0	0.0	0.4	100.0
1963	6.8	0.7	91.8	0.0	0.0	0.7	100.0
1964	5.9	1.1	92.3	0.0	0.0	0.7	100.0
1965	6.4	1.3	84.0	0.0	0.0	8.3	100.0
1966	7.1	0.6	73.8	0.0	0.0	18.5	100.0
1967	8.4	0.6	77.7	0.0	0.0	13.3	100.0
1968	9.7	0.9	63.4	0.0	0.0	26.0	100.0
1969	11.2	0.7	66.7	0.0	0.0	21.4	100.0
1970	13.4	0.9	63.9	5.2	0.0	16.6	100.0
1971	18.2	0.9	55.5	9.4	0.0	16.0	100.0
1972	17.0	0.8	55.0	7.7	0.0	19.5	100.0
1973	17.5	0.4	47.0	6.1	0.0	29.0	100.0
1974	16.2	5.7	51.1	8.8	0.0	18.2	100.0
1975	14.2	8.0	42.5	10.3	0.0	25.0	100.0
1976	19.3	4.1	48.6	5.6	0.0	22.4	100.0
1977	17.8	2.9	48.3	2.9	0.0	28.1	100.0
1978	12.4	6.9	52.7	15.0	0.0	13.0	100.0
1979	12.9	25.4	40.2	13.4	0.0	8.4	100.0
1980	13.8	28.7	40.5	11.8	0.0	5.2	100.0
1981	9.3	24.0	33.2	10.3	0.0	23.2	100.0
1982	9.1	25.9	33.8	15.8	0.1	15.3	100.0
1983	14.2	27.5	33.9	16.0	0.2	8.2	100.0
1984	15.1	29.9	29.4	13.6	0.2	11.8	100.0
1985	14.8	23.1	22.5	13.6	0.3	25.7	100.0
1986	18.9	35.8	19.1	19.9	0.3	6.0	100.0
1987	13.0	36.2	15.9	7.3	0.1	27.5	100.0

Source: Energy, Mines and Resources Canada.

accounted for about 9 per cent of total energy export revenue. In terms of net revenue, however, electricity accounted for 16 per cent, as shown in Figure 7.2.

INTERPROVINCIAL TRADE

Annual Canadian interprovincial electricity trade for the period 1960-87 is summarized in Table 7.11. When the Churchill Falls hydro project began producing electricity in 1972, the volume of interprovincial electricity trade increased substantially because Newfoundland sold almost all of the output to Quebec under contract. Interprovincial electricity trade reached a peak in 1975, accounting for about 18 per cent of total Canadian generation; the percentage has declined gradually since then. By 1987, interprovincial electricity trade accounted for 10.2 per cent of total production, down from 11.1 per cent in 1986.

Interprovincial transfers during the period 1978-87 are summarized in Table 7.12. More information on exports and imports by province is provided in Figure 7.3 and Table A5 in Appendix A.

Table 7.10. Canadian energy trade, 1978-1987

	Oil	Natural Gas	Coal	Electricity	Uranium	Total Energy
			(millions of dollars)			
1978						
Exports	2 568	2 190	704	479	207	6 599
Imports	3 767	0	712	2	12	4 493
Balance	-1 199	2 190	-8	477	195	2 106
1979						
Exports	4 265	2 889	750	729	379	9 614
Imports	4 798	3	934	1	12	5 748
Balance	-533	2 886	-184	728	367	3 866
1980						
Exports	4 891	3 984	824	773	231	11 328
Imports	7 487	0	885	2	17	8 391
Balance	-2 596	3 984	-61	771	214	2 937
1981						
Exports	5 228	4 370	1 065	1 123	178	12 636
Imports	8 627	0	928	6	15	9 576
Balance	-3 399	4 370	137	1 117	163	3 060
1982						
Exports	5 218	4 755	1 203	1 120	359	13 089
Imports	5 763	1	1 017	5	17	6 793
Balance	-545	4 754	186	1 115	342	6 296

Table 7.10. Canadian energy trade, 1978-1987 (Continued)

	Oil	Natural Gas	Coal	Electricity	Uranium	Total Energy
			(millions of dollars)			
1983						
Exports	6 338	3 958	1 247	1 228	63	13 201
Imports	4 221	1	941	3	15	5 180
Balance	2 117	3 957	306	1 225	48	8 020
1984						
Exports	7 580	3 886	1 851	1 379	334	15 718
Imports	4 919	0	1 203	13	15	6 150
Balance	2 661	3 886	648	1 366	319	9 421
1985						
Exports	9 239	3 912	2 030	1 408	232	17 411
Imports	5 242	0	1 023	8	28	6 301
Balance	3 997	3 912	1 007	1 400	204	11 110
1986						
Exports	5 854	2 483	1 869	1 080	842	12 128
Imports	3 082	0	874	9	31	5 293
Balance	2 772	2 483	995	1 071	811	6 835
1987						
Exports	8 029	2 527	1 696	1 211	886	13 349
Imports	4 810	0	844	12	18	5 683
Balance	3 219	2 527	852	1 199	868	7 666

Source: Statistics Canada, Exports by Commodities *(65-004) and* Imports by Commodities *(65-007).*

Table 7.11. Annual Canadian interprovincial electricity trade, 1960-1987

Year	Total Canadian Generation (GW.h)	Delivered to other Provinces (GW.h)		Percentage of Interprovincial Transfers to Total Generation	
		With Churchill Falls	Without Churchill Falls	With Churchill Falls	Without Churchill Falls
1960	114 378	7 108	7 108	6.2	6.2
1961	113 713	7 411	7 411	6.5	6.5
1962	117 469	7 188	7 188	6.1	6.1
1963	122 238	6 586	6 586	5.4	5.4
1964	134 987	8 241	8 241	6.1	6.1
1965	144 274	6 230	6 230	4.3	4.3
1966	158 135	7 771	7 771	4.9	4.9
1967	165 625	6 874	6 874	4.2	4.2
1968	176 378	6 578	6 578	3.7	3.7
1969	191 102	6 338	6 338	3.3	3.3
1970	204 723	8 137	8 137	4.0	4.0
1971	216 472	8 047	7 870	3.7	3.6
1972	240 213	17 787	11 470	7.4	4.8
1973	263 335	28 933	15 129	11.0	5.8
1974	279 915	40 768	18 624	14.6	6.7
1975	273 392	49 198	19 684	18.0	7.2
1976	294 043	51 931	19 909	17.7	6.8
1977	316 940	52 005	18 739	16.4	5.9
1978	335 946	53 645	16 706	16.0	5.0
1979	353 051	49 847	14 642	14.1	4.2
1980	367 306	52 709	14 965	14.4	4.1
1981	380 131	51 181	15 325	13.5	4.0
1982	376 805	50 303	14 609	13.4	3.9
1983	395 850	46 007	14 863	11.6	3.8
1984	425 414	53 302	17 375	12.5	4.1
1985	446 413	51 663	19 917	11.6	4.5
1986	455 795	50 706	20 102	11.1	4.4
1987	482 108	49 201	18 808	10.2	3.9

Source: Energy, Mines and Resources Canada.

Figure 7.1. Net electricity exports and Canadian merchandise trade balance, 1987

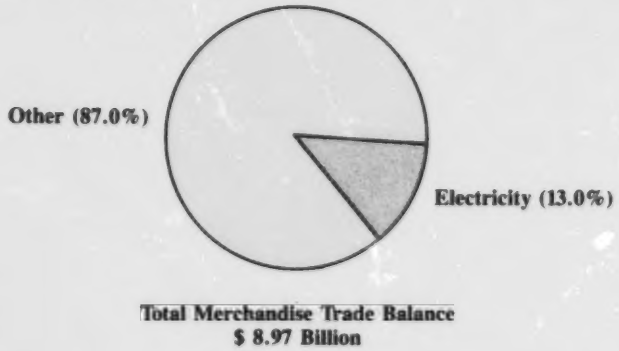
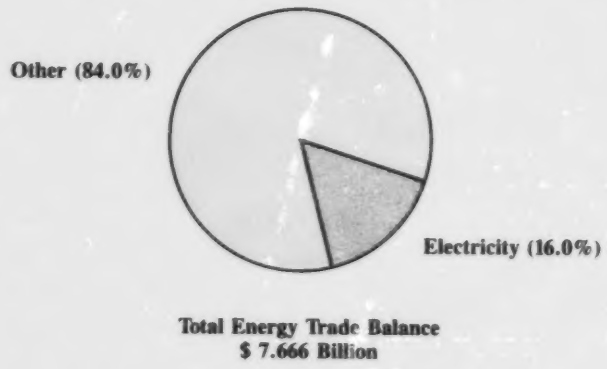


Table 7.12. Interprovincial electricity trade by destination, 1978-1987

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
						(GW.h)				
Newfoundland to Quebec	37 024	35 290	37 829	35 941	35 779	31 229	36 012	31 836	30 695	30 393
Nova Scotia to New Brunswick	40	151	226	112	133	121	271	190	71	82
New Brunswick to Nova Scotia	264	494	172	303	217	737	303	360	620	659
New Brunswick to P.E.I.	270	362	392	481	478	520	550	585	610	483
New Brunswick to Quebec	0	0	0	0	0	1	0	2	0	20
Quebec to New Brunswick	3 546	3 588	3 675	3 717	3 615	3 971	4 342	5 951	7 204	6 840
Quebec to Ontario	8 661	5 389	5 567	6 494	5 768	5 378	7 364	8 685	7 292	5 942
Ontario to Quebec	456	204	50	58	57	52	68	106	17	15
Ontario to Manitoba	2	23	0	0	3	13	2	0	5	3
Manitoba to Ontario	1 257	1 827	1 575	1 164	1 066	955	940	959	735	1 050
Manitoba to Saskatchewan	790	1 248	1 579	1 305	1 488	1 610	1 593	1 530	1 211	1 262
Saskatchewan to Manitoba	828	774	951	1 054	1 066	1 209	1 299	1 240	1 076	1 220
Saskatchewan to Alberta	0	0	4	3	3	2	3	0	0	0
Alberta to Saskatchewan	0	0	0	0	0	4	0	0	0	0
Alberta to B.C.	280	394	385	261	188	46	259	182	617	710
B.C. to Alberta	227	103	100	165	442	163	296	37	553	521
Total	53 645	49 847	52 709	51 181	50 303	46 007	54 302	51 663	50 706	49 201

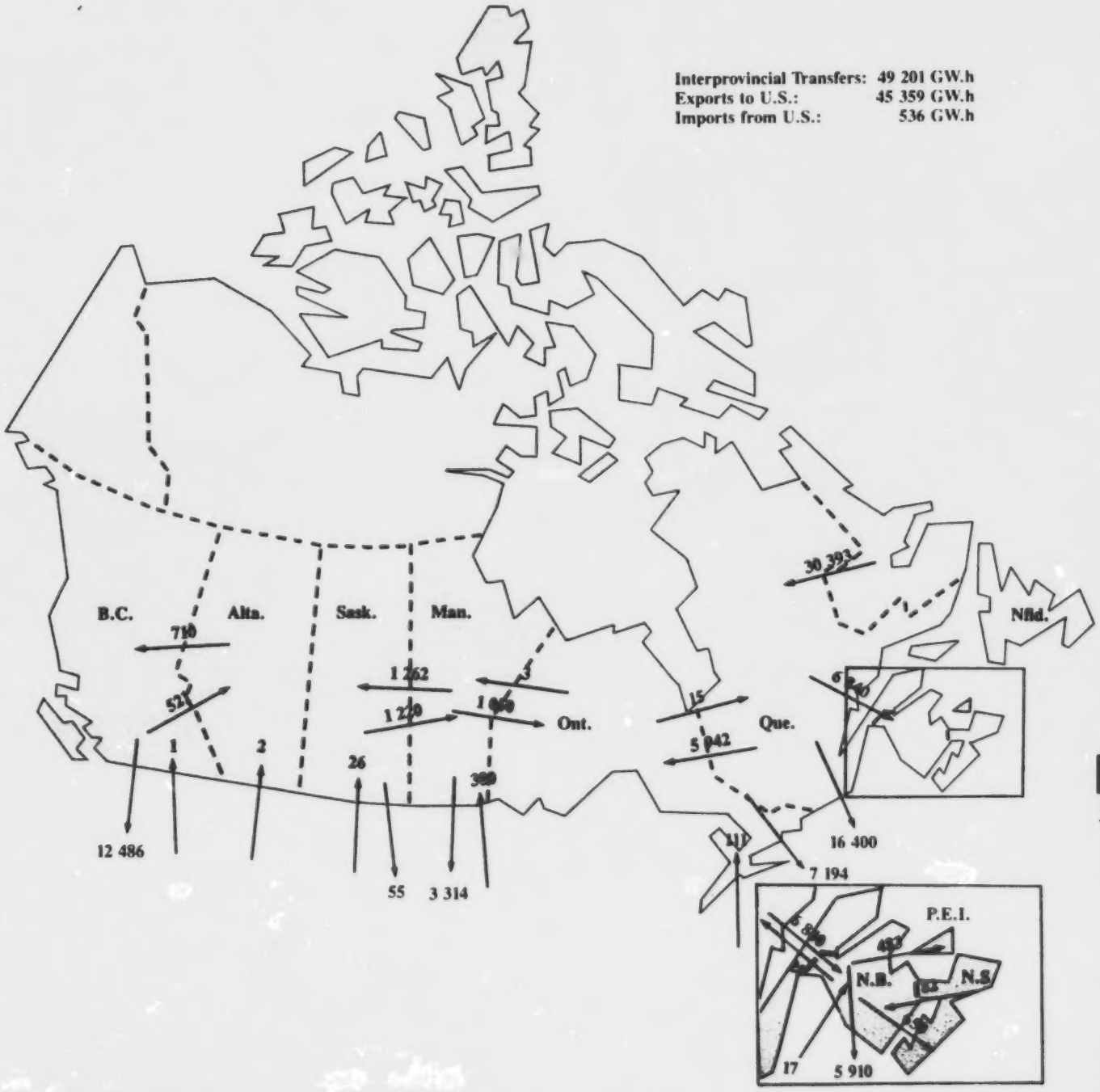
Source: Energy, Mines and Resources Canada.

Figure 7.2. Net electricity exports and Canadian energy trade balance, 1987



An Alberta Power employee makes repairs to one of the company's lines near Vegreville, Alberta.

Figure 7.3. Electricity trade, 1987 (GW.h)



A 500-kV tower goes up at Edmonton Power's coal-fired Genesee generating station. Genesee will add 400 MW to the Alberta Interconnected System when it comes on line in late 1989.

8. Transmission

Total circuit length of electrical transmission in Canada, for lines rated at 50 kV and above, increased by 853 km in 1987. The total distance of Canadian transmission is now 147 756 km. The largest share of it (32 per cent) is in the 100 kV to 149 kV range. Another 25 per cent is in the 200 kV to 299 kV range, while 21 per cent is between 50 kV and 99 kV. Newfoundland and Quebec are the only two provinces with transmission lines over 600 kV; their circuit length is 10 520 km, about 7 per cent of the Canadian total. Quebec has the greatest amount of electrical transmission, with 34 567 km, or 23 per cent of Canada's total. It is followed by Ontario with 19 per cent, and Alberta and Manitoba with 12 per cent each.

Transmission circuit length by province and voltage is reported in Table 8.1.

The additions in 1987 were mainly in Manitoba, Alberta, Quebec, and Newfoundland. The Alberta Interconnected System increased its 240-kV lines by 222 km. Manitoba Hydro extended its 138-kV line by 270 km. Newfoundland and Labrador Hydro increased its system by 105 km with the addition of one 138-kV line. Other minor additions to transmission lines within the provinces occurred in Prince Edward Island, New Brunswick, and Quebec.

There are several transmission lines now under construction. Ontario is in the process of adding three 500-kV lines, with two scheduled to be completed in 1988 and the third in 1989. The new lines will increase Ontario's total circuit length by 448 km. In Saskatchewan, a 138-kV line is under construction and is expected to increase the province's transmission system by 355 km. A 230-kV line with a circuit length of 123 km is also under construction in Manitoba.

INTERPROVINCIAL TRANSMISSION

Table 8.2 presents the major provincial interconnections. Currently, there are 32 interties, with a total design capability of 9895 MW. Although there were no additions to interprovincial

Table 8.1. Transmission circuit length in Canada, 1987

	50 - 99 kV	100 - 149 kV	150 - 199 kV	200 - 299 kV	300 - 399 kV	400 - 599 kV	600 kV and up	Total
Nfld.	2 211	1 827	-	2 005	-	-	612	6 655
P.E.I.	371	173	-	-	-	-	-	544
N.S.	2 132	1 703	-	1 150	173	-	-	5 158
N.B.	2 776	1 897	-	528	1 057	-	-	6 258
Que.	4 251	7 534	2 180	3 671	7 023	-	9 908	34 567
Ont.	291	12 305	-	13 461	6	2 233	-	28 296
Man.	6 690	4 526	-	4 157	-	2 042	-	17 415
Sask.	4 820	3 702	-	2 629	-	-	-	11 151
Alta.	3 458	8 571	159	5 225	-	356	-	17 715
B.C.	4 799	4 235	264	3 759	403	5 344	-	13 460
Yukon	64	497	-	-	-	-	-	561
N.W.T.	129	503	-	-	-	-	-	632
Canada	31 992 (21%)	47 419 (32%)	2 603 (2%)	36 585 (25%)	8 662 (6%)	9 975 (7%)	10 520 (7%)	147 756 (100%)

Source: Statistics Canada publication 57-202.
Energy, Mines and Resources Canada.

interconnections in 1987, Manitoba began construction of a 115-kV line to replace an existing one that runs from the Seven Sisters generating station in Manitoba to Kenora, Ontario. The new line will have a total circuit length of 81 km. One important interconnection was proposed in 1987. SaskPower and Alberta Power Ltd. signed an agreement to jointly construct a $41-million high-voltage-direct-current (HVDC) interconnection linking the electrical systems of the two provinces. This interconnection will run from Swift Current, Saskatchewan, to Empress, Alberta, and will enable Alberta and Saskatchewan to share 100 MW of generation resources and allow electric power sales between the two provinces. The interconnection will involve 175 km of 230-kV transmission line in Saskatchewan and 10 km of 138-kV line in Alberta. It will be the first Canadian link between the eastern and western power systems of North America. Construction of the interconnection, which is subject to regulatory approval in both provinces, is scheduled to begin in mid-1988 and be completed late the following year.

Table 8.2. Provincial interconnections at year end, 1987

Connection	Voltage	Design Capability*
	(kV)	(MW)
British Columbia - Alberta	1 × 500	800
	1 × 138	110
Saskatchewan - Manitoba	3 × 230	400
Manitoba - Ontario	2 × 230	260
	1 × 115	
Ontario - Quebec	4 × 230	1 300
	7 × 120	
Quebec - Newfoundland	3 × 735	5 225
Quebec - New Brunswick	2 × ±80 (DC)	700
	2 × 345	
	2 × 230	300
New Brunswick - Nova Scotia	2 × 138	600
	1 × 345	
New Brunswick - P.E.I.	1 × 138	200

** Actual transfer capability in practice will be different from design capability.*

Source: Energy, Mines and Resources Canada.

INTERNATIONAL TRANSMISSION

There are now over 100 international transmission lines in place to provide for Canada's international trade in electricity. Although most of these lines are quite small, there are 36 bulk power interties rated at 69 kV or higher, with a total power transfer capacity of 13 500 MW. These are presented in Table 8.3.

LONG-DISTANCE TRANSMISSION

Canada is a world leader in long-distance electric power transmission, in both extra-high-voltage (EHV) alternating current and HVDC. A major influence on the development of Canada's expertise in these areas has been the country's abundant water power resources. Early in the century, pioneering efforts in high-voltage transmission resulted in the initial development of hydroelectric power at Niagara Falls, to supply the growing needs of communities in southern Ontario. In Quebec, the first 50-kV transmission lines were constructed to bring power from Shawinigan to Montreal.

After the harnessing of the major hydroelectric sites close to load centres, it became necessary to develop remote hydroelectric sources in several provinces and to integrate these sources into the power system over long-distance EHV and HVDC transmission lines. In 1965, Hydro-Québec installed the world's first 700-kV class transmission system. This system now extends over 1100 km from the Churchill Falls development in Labrador to Montreal; a comparable system of about the same distance extends from the James Bay development to Quebec's load centres.

In Manitoba, pioneering work was done to develop the ±450-kV HVDC system, which now brings hydroelectric power from the Nelson River generating stations to customers in southern Manitoba. Ontario and British Columbia also have extensive EHV systems in the 500-kV class. All of these systems are shown in Figure 8.1.

Such advances in Canadian transmission techniques have provided not only for long-distance

Table 8.3. Major interconnections between Canada and the United States*

Province	State	Voltage	Design Capability***
		(kV)	(MW)
New Brunswick	*Maine*	1 × 345	600
		1 × 138	60
		5 × 69	155
Quebec	*New York*	1 × 765	1 400
	New York	2 × 120	200
	Vermont	2 × 120	200
	New Hampshire	±450(DC)	690
*Ontario***	*New York*	1 × 230	470
		1 × 230	400
		2 × 230	600
		2 × 345	2 300
		2 × 69	132
		2 × 115	200
	Michigan	1 × 230	535
		1 × 230	515
		2 × 345	1 470
	Minnesota	1 × 120	35
Manitoba	*North Dakota*	1 × 230	150
	Minnesota	1 × 230	175
	Minnesota	1 × 500	1 000
Saskatchewan	*North Dakota*	1 × 230	150
British Columbia	*Washington*	1 × 230	350
		1 × 230	300
		2 × 500	1 400

* *35 MW capacity or over.*

** *The transfer capability of several lines may not be equal to the mathematical sum of the individual transfer capabilities of the same lines.*

*** *Actual transfer capability in practice will be different from design capability.*

Source: Energy, Mines and Resources Canada.

bulk transmission, but also for extensive interconnections between neighbouring provinces (32 interties) and between Canada and the United States (over 100 interties). Figure 8.2 indicates the major provincial and international interconnections.

Figure 8.1. Canada's major long-distance transmission systems, 1987

Figure 8.2. Major provincial and international interconnections, 1987

9. Electric Utility Investment and Financing

CAPITAL INVESTMENT

Every year, electric utilities make investments in new facilities or upgrade old facilities to meet their customers' needs. Between 1971 and 1987, electric utility capital investment increased from $1.8 billion to $6.2 billion, with an average annual growth rate of 8.3 per cent. Table 9.1 illustrates the capital-intensive nature of electricity and its importance in the Canadian economy. Before 1980, electric utility investment in Canada was more than 50 per cent of total investment in the energy sector. This share reached a peak of 58 per cent in 1978 and then gradually declined, reflecting surplus capacity in the industry. However, the investment share of the electrical industry has increased significantly in the past two years. Electric utility capital investment accounted for 47 per cent of the total investment in the energy sector in 1987, as compared with 41 per cent in 1986 and only 34 per cent in 1985.

Electric utility investment in Canada, as a share of both total investment in the economy and GDP, has declined since 1982. In 1978, the investment share of the electric power industry accounted for 11 per cent of total investment in the economy, and 2.5 per cent of GDP. These shares dropped to 5 per cent and 1.1 per cent respectively in 1987.

Table 9.2 summarizes capital expenditures in the energy sector. During the period 1971-87, the electric power industry had the largest investment share in the energy sector, with the exception of 1984 and 1985, when crude oil and natural gas had the largest share.

Of the $6.2 billion capital investment in 1987, about 46 per cent was for generation, 20 per cent for transmission, and 19 per cent for distribution. Figure 9.1 shows

Table 9.1. Electric utility capital investment, 1971-1987

	Investment in electric power industry ($ million)	As a percentage of total energy investment	As a percentage of total investment in the economy	As a percentage of GDP
1971	1 747	52	8	1.8
1972	1 754	49	7	1.6
1973	2 244	53	8	1.8
1974	2 753	53	8	1.8
1975	3 957	58	9	2.3
1976	4 229	55	9	2.1
1977	4 884	56	10	2.2
1978	5 936	58	11	2.5
1979	6 364	53	10	2.3
1980	6 109	42	8	2.0
1981	7 319	40	9	2.1
1982	8 408	39	10	2.2
1983	7 770	42	10	1.9
1984	6 340	37	8	1.4
1985	5 729	34	6	1.2
1986	5 618	41	6	1.1
1987	6 233	47	5	1.1

Source: Energy, Mines and Resources Canada.

Figure 9.1. Capital investment by function, 1987

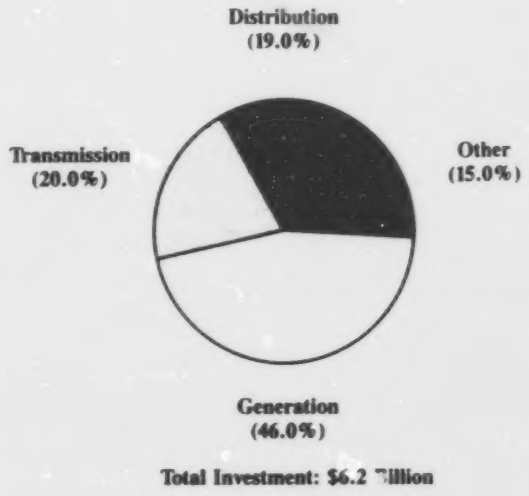


Table 9.2. Investment in energy-related industries, 1971-1987

Year	Crude oil and natural gas	Refined petroleum and coal products	Natural gas distribution	Electric power	Coal mines	Uranium mines	Other*	Total
				(millions of dollars)				
1971	463	231	115	1 747	90	6	702	3 381
1972	666	244	142	1 754	37	11	683	3 567
1973	824	319	146	2 244	39	18	589	4 220
1974	1 088	430	192	2 753	88	35	546	5 151
1975	1 390	450	193	3 957	121	30	662	6 831
1976	1 868	344	182	4 229	191	66	666	7 676
1977	2 251	367	213	4 884	248	113	666	8 782
1978	2 271	315	247	5 936	219	180	745	10 258
1979	3 886	274	263	6 364	214	243	793	12 037
1980	5 745	325	386	6 109	299	277	1 317	14 458
1981	6 445	848	409	7 319	576	289	2 285	18 419
1982	6 743	1 231	518	8 408	1 024	405	2 389	21 339
1983	6 564	841	577	7 770	1 225	413	1 190	18 715
1984	6 947	432	604	6 340	832	186	1 262	16 943
1985	8 184	336	604	5 729	471	160	1 101	16 925
1986	5 401	398	574	5 618	429	144	962	13 733
1987	4 331	660	534	6 233	355	106	1 168	13 348

** Natural gas processing plants, transportation, marketing, and oil and gas drilling contractors.*

Source: Energy, Mines and Resources Canada.

Table 9.3. Capital investment by function, 1971-1987

Year	Generation	Transmission	Distribution	Other	Total
			(millions of current dollars)		
1971	915	520	239	73	1 747
1972	1 020	432	229	73	1 754
1973	1 252	366	286	340	2 244
1974	1 805	388	422	138	2 753
1975	2 460	616	547	334	3 957
1976	2 576	794	464	395	4 229
1977	3 085	907	519	373	4 884
1978	3 499	1 290	499	648	5 936
1979	3 892	1 266	570	636	6 364
1980	3 580	1 114	703	712	6 109
1981	4 552	1 387	647	733	7 319
1982	5 026	1 436	937	1 009	8 408
1983	4 882	1 270	766	852	7 770
1984	3 530	1 158	834	818	6 340
1985	2 941	836	1 008	944	5 729
1986	3 214	815	989	600	5 618
1987	2 908	1 258	1 089	978	6 233

Source: Energy, Mines and Resources Canada.

electric utility capital investment by function in 1987. Table 9.3 summarizes capital investment by function for the period 1971-87. Over the past 17 years, the generation component accounted for approximately 59 per cent of total capital investment, while transmission accounted for 18 per cent, distribution 12 per cent, and other investment 9 per cent.

Table 9.4 reports the capital investment of 14 major electric utilities in 1986 and 1987. With the exception of Nova Scotia Power, Ontario Hydro, Alberta Power, TransAlta Utilities and B.C. Hydro, all major utilities increased their capital investment in 1987. Ontario Hydro accounted for about 46 per cent of total utility capital investment in 1987, most of which was related to the ongoing construction of the Darlington nuclear station.

Table 9.4. Capital investment by major electric utility

	1986	1987	Year-over-year change
	(millions of current dollars)		(per cent)
Newfoundland and Labrador Hydro	28	45	7.7
Newfoundland Light & Power	33	40	21.2
Maritime Electric Co. Ltd.	9	12	33.3
Nova Scotia Power	124	117	-6.6
N.B. Power	80	86	7.5
Hydro-Québec	1 537	1 688	9.8
Ontario Hydro	2 641	2 638	-0.1
Manitoba Hydro	223	319	43.0
Saskatchewan Power	187	134	-35.5
Alberta Power	157	133	-15.3
Edmonton Power	129	191	48.1
TransAlta Utilities	231	164	-9.8
B.C. Hydro	148	141	-23.7
Northern Canada Power Commission	14	17	21.4
Canada	5 541	5 725	3.3

Source: Energy, Mines and Resources Canada.

Table 9.5. Major electric utility long-term debt and sources of financing, 1986

	Long-Term Debt	Sources of Long-Term Debt Financing	
	($ millions)	Domestic (%)	Foreign (%)
Newfoundland and Labrador Hydro	1 412	39	61
Newfoundland Light & Power	134	93	7
Maritime Electric Co. Ltd.	18	100	0
Nova Scotia Power	1 591	76	24
N.B. Power	2 089	38	62
Hydro-Québec	20 349	41	59
Ontario Hydro	23 494	57	43
Manitoba Hydro	2 652	38	62
Saskatchewan Power	2 162	71	29
Alberta Power	428	100	0
Edmonton Power	623	100	0
TransAlta Utilities	992	94	6
B.C. Hydro	7 472	47	53
Northern Canada Power Commission	96	100	0
Canada	63 512	54	46

Source: Energy, Mines and Resources Canada.

Table 9.6. Comparison of Canadian and U.S. electric utility debt ratios

	1984	1985	1986
	(per cent)		
CANADA			
Publicly owned utilities			
Newfoundland and Labrador Hydro	91	90	88
Nova Scotia Power	94	95	96
N.B. Power	89	88	84
Hydro-Québec	75	76	76
Ontario Hydro	83	84	84
Manitoba Hydro	97	96	96
Winnipeg Hydro	67	68	72
Saskatchewan Power	86	87	87
Edmonton Power	84	80	75
B.C. Hydro	87	86	86
Northern Canada Power Commission	95	96	82
Investor-owned utilities			
Newfoundland Light & Power	46	46	45
Maritime Electric Co. Ltd.	48	43	42
TransAlta Utilities Corporation	42	43	45
Alberta Power	45	43	45
UNITED STATES			
Publicly owned utilities			
Tennessee Valley Authority	84	83	83
Bonneville Power Administration	100	100	100
Power Authority of the State of New York	69	71	72
Investor-owned utilities			
Boston Edison Company	50	51	46
Northeast Utilities	52	53	52
Consolidated Edison Company of New York	34	36	36
Niagara Mohawk Power Corporation	46	46	47
American Electric Power Company	54	53	53
Northern States Power Company	46	46	46
Washington Water Power Company	48	44	48
Pacific Gas and Electric Company	46	48	46

Source: Energy, Mines and Resources Canada.

FINANCING

Electric utilities in Canada normally borrow a portion of their capital requirements from the United States, Western Europe, and Japan. Table 9.5 shows that the outstanding long-term debt of major utilities in Canada was about $64 billion as of December 31, 1986. It is estimated that about $34 billion (54 per cent) was borrowed from domestic markets and $30 billion (46 per cent) from international markets. Of the total $30 billion borrowed internationally, it is estimated that about $26 billion (87 per cent) came from the United States.

Table 9.6 indicates that in 1986 Canadian publicly owned electric utilities had debt ratios ranging from 72 per cent for Winnipeg Hydro to about 96 per cent for Nova Scotia Power and Manitoba Hydro. The debt ratios for investor-owned utilities ranged from 42 per cent to 45 per cent.

High debt ratios, similar to those of Canadian publicly owned utilities, were also common among government-owned utilities in the United States. As Table 9.6 indicates, the Power Authority of the State of New York, the Tennessee Valley Authority, and the Bonneville Power Administration had debt ratios of 72 per cent, 83 per cent, and 100 per cent, respectively. The selected American investor-owned utilities had debt ratios ranging from 36 per cent to 53 per cent, in 1986.

10. Costing and Pricing

ELECTRICITY SUPPLY COSTS

The unit cost of supplying additional electricity increased rapidly during the period 1974-82. However, cost increases have moderated significantly since then. Adjusted for inflation, recent increases in the cost of electricity have been small, and this is expected to be the case for the next several years.

Between 1974 and 1982, there were two key reasons for the rapid increases in the cost of electricity: the high rate of inflation, with an average increase of 10 per cent annually; and the increased cost of fossil fuels, with an average annual increase of 18 per cent. High levels of inflation affect the electric utility industry by increasing the cost of constructing additional facilities and by increasing the cost of borrowed funds.

The average interest rate on new long-term utility debt for the period 1967-87 is shown in Table 10.1. Interest rates started to rise in 1974, which coincided with the first oil crisis, and reached a peak in 1981, after which they dropped substantially. In 1987, interest rates averaged 10.9 per cent, slightly higher than the 10.5 per cent rate registered in 1986.

The indices of electric utility construction costs, presented in Table 10.1, show that increases in hydro, steam, and nuclear construction costs between 1969 and 1976 exceeded increases in the CPI. However, since 1977 increases in the CPI have consistently exceeded increases in construction costs, with some minor exceptions for steam in 1979-80 and 1986, and hydro in 1981. The average increase in electric utility construction costs during the period 1967-86 was 7.4 per cent for hydro projects, 7.8 per cent for thermal stations, and 7.8 for nuclear during the period 1971-87, compared to 7.3 per cent for the CPI. In general, electricity construction costs tend to parallel the CPI.

Table 10.1. Inflation, interest rates, and construction costs, 1967-1987

	Average Interest Rate	Increase in Construction Costs			CPI
		Hydro	Steam	Nuclear	
	(per cent)				
1967	6.7	3.6	1.1	-	3.5
1968	7.8	4.2	2.8	-	4.7
1969	8.6	5.7	6.8	-	4.5
1970	9.3	6.6	7.4	-	3.3
1971	8.5	4.6	6.0	-	2.9
1972	8.4	6.3	6.1	6.9	4.8
1973	8.6	9.2	9.2	9.5	7.6
1974	10.2	18.8	20.5	19.2	10.9
1975	10.7	14.3	13.4	13.1	10.8
1976	10.4	8.9	10.0	9.7	7.5
1977	9.6	5.9	7.9	7.5	8.0
1978	10.0	7.7	8.7	8.0	9.0
1979	10.9	8.7	11.0	12.7	9.2
1980	13.3	10.0	11.6	22.0	10.2
1981	16.3	13.7	11.9	11.4	12.5
1982	15.9	7.2	6.8	5.3	10.8
1983	12.8	4.6	4.1	5.0	5.8
1984	12.5	3.2	2.8	0.1	4.4
1985	11.7	1.7	3.8	4.8	4.0
1986	10.5	4.1	3.5	3.5	4.1
1987	10.9	3.0	2.7	1.9	4.1

Source: Interest rates - McLeod Young Weir Ltd.
Construction costs and CPI - Statistics Canada publications 62-007 and 62-001.

Increases in fossil-fuel costs since 1969 are summarized in Table 10.2. Fuel costs for electricity generation were generally stable until the oil crisis of 1973, when they began to rise. For Canada as a whole, the fuel cost per kW.h of electricity generated from fossil fuels increased more than three times between 1973 and 1986, from 3.1 mills to 10.7 mills. The increase in the cost of fuel from oil generation was much more dramatic, growing from 7.1 mills to 68.02 mills per kW.h during the period 1973-85, an average annual increase of 21 per cent. However, the cost of oil-fired generation declined substantially in 1986, because of the collapse of world oil prices.

The unit cost of fuel generated from coal varies between regions of the country and depends on the type of coal used, its source, and the percentage of total energy supply derived from fossil-fuel plants. The unit fuel cost of electricity generated from western Canadian coal increased from 1.4 mills per kW.h in 1973 to 5.1 mills per kW.h in 1986. In the same period, the cost of coal-fired generation in eastern Canada increased from 4.7 mills to 25.9 mills. Coal used for electricity generation in western Canada is produced domestically, while a large proportion of the coal used in eastern Canada is imported.

Table 10.2. Cost of fuel for electricity generation, 1969-1986

	Eastern Coal*	Western Coal**	Petroleum	Natural Gas	Uranium	Total Fuels
			(mills/kW.h)			
1969	3.46	1.11	4.97	2.54	-	3.24
1970	3.60	1.38	5.68	2.47	-	3.25
1971	4.20	1.28	5.98	3.15	-	3.46
1972	4.32	1.34	6.41	3.93	-	3.42
1973	4.65	1.43	7.06	3.74	-	3.13
1974	5.38	1.54	11.36	5.18	-	4.10
1975	8.64	2.07	12.87	7.17	-	6.16
1976	11.43	2.97	15.38	11.74	1.14	8.11
1977	11.89	3.20	19.01	15.21	1.34	8.40
1978	13.12	2.88	21.22	16.19	1.61	8.82
1979	16.50	3.11	23.93	15.22	1.65	9.62
1980	18.22	3.75	26.22	15.47	2.65	10.69
1981	20.48	4.83	40.77	23.22	2.68	12.22
1982	22.61	5.76	44.88	30.16	2.87	14.04
1983	23.71	5.96	57.27	31.17	3.25	13.20
1984	24.85	5.94	65.11	34.15	3.84	13.64
1985	26.07	6.59	68.02	31.81	4.74	13.54
1986	25.88	5.13	45.15	27.11	4.52	10.70

* *Nova Scotia, New Brunswick, and Ontario.*
** *Alberta, Saskatchewan, and Manitoba.*

Source: Calculated from Electric Power Statistics, *Statistics Canada, Catalogue 57-202, various issues.*

The unit fuel cost of electricity generated from natural gas increased substantially between 1973 and 1986, from 3.7 mills per kW.h to 27.1 mills per kW.h, an average increase of about 17 per cent. Over the last 11 years, nuclear-generated electricity has had the lowest unit fuel cost in Canada. In 1986, it cost 4.5 mills per kW.h, compared with 45.2 mills for petroleum, 27.1 mills for natural gas, 25.9 mills for coal burned in eastern Canada, and 5.1 mills for coal used in western Canada. In 1986, all fuel costs for electricity generation were reduced substantially, reflecting the collapse of international oil prices.

PRICING

The average revenue from electricity sales for each province is provided in Table 10.3. Income statements for the major utilities are summarized in Table 10.4. Because electricity rates are regulated to cover costs, the average revenue per unit of electricity began to increase significantly in 1975, with the escalation in the cost of electricity generation. The average annual growth in unit revenue for Canada as a whole was 9.7 per cent during the period 1977-86. The national inflation rate, as measured by the CPI, was 7.8 per cent over the same period. The average revenue from electricity sales for Canada as a whole declined by 2 per cent in 1986, the first decrease since 1966.

Electricity costs differ across the country primarily because of differences in generation mix and the size and geographic distribution of the population being served. Table 10.5 gives monthly electricity costs for selected Canadian cities as of January 1987. Winnipeg had the lowest electricity costs in Canada in all three sectors; Yellowknife had the highest in both the residential and commercial sectors, while Charlottetown had the highest in the industrial sector. Table 10.6 details the average annual rate increases for customers in each province since 1978. In 1987, there were two electric utilities with negative rate changes: Alberta Power and TransAlta.

Figure 10.1 illustrates the movement of the electricity, oil, and natural gas components of the CPI, as well as the CPI itself. It indicates

Table 10.3. Average revenue from electricity sales by province, 1977-1986

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
	(current cents/kW.h)									
Nfld.	1.7	2.0	2.2	2.3	2.8	3.6	3.7	3.9	4.7	3.9
P.E.I.	5.9	6.4	7.2	8.1	10.0	12.0	12.3	12.8	12.9	11.5
N.S.	3.9	4.4	4.6	4.5	4.9	5.9	6.9	7.5	7.3	6.9
N.B.	2.4	3.2	3.7	4.1	4.8	5.1	5.4	5.5	5.8	5.5
Que.	1.5	1.7	2.0	2.2	2.6	3.1	3.4	3.4	3.5	3.4
Ont.	2.3	2.4	2.6	2.9	3.2	3.6	3.9	4.2	4.5	4.5
Man.	1.9	2.3	2.7	2.8	2.8	2.9	3.1	3.4	3.6	3.6
Sask.	2.4	2.7	2.7	2.9	3.6	4.0	4.2	4.5	4.8	5.0
Alta.	2.7	3.1	3.2	3.4	4.1	4.9	5.2	5.4	5.4	5.4
B.C.	2.1	2.2	2.4	2.6	3.0	3.8	3.8	4.1	4.4	4.2
Yukon	4.1	4.4	4.9	5.3	6.7	8.3	8.3	8.6	9.0	7.8
N.W.T.	6.9	7.7	9.0	10.0	11.5	14.8	17.9	16.7	16.3	15.9
Canada	2.0	2.3	2.5	2.8	3.1	3.7	3.9	4.1	4.3	4.2

Source: Statistics Canada publication 57-202.

Table 10.4. Major electric utilities' statements of income, 1986

	Total Revenue	O&M	Fuel Costs	Power Purchased	Depre-ciation	Taxes	Interest	Exchange Losses	Other Costs	Net Income
	(millions of current dollars)									
Newfoundland and Labrador Hydro	321	53	54	1	23	-	154	-	-	36
Newfoundland Light & Power	245	38	-	140	17	15	16	-	-	19
Maritime Electric Co. Ltd.	54	15	-	22	3	5	4	-	-	5
Nova Scotia Power	484	69	173	12	48	5	147	-	39	(9)
N.B. Power	825	91	131	120	81	-	261	-	112	29
Hydro-Québec	4 734	1 129	-	118	464	272	2 259	189	-	303
Ontario Hydro	4 853	1 014	933	128	705	91	1 585	213	(63)	247
Manitoba Hydro	570	188	-	10	78	38	177	66	-	13
Winnipeg Hydro	84	25	-	36	3	1	7	-	1	11
Saskatchewan Power	847	228	289	-	95	-	245	-	-	(10)
Alberta Power	375	21	128	-	43	73	52	-	-	-
Edmonton Power	271	41	-	93	17	21	14	1	7	77
TransAlta Utilities	916	192	-	13	135	225	148	-	149	54
B.C. Hydro	1 987	278	280	-	233	330	906	-	(65)	25
Northern Canada Power Commission	99	68	-	-	12	-	23	-	3	(1)
Canada	16 665	3 450	1 988	693	1 957	1 076	5 998	469	176	858

Source: Obtained from electric utilities' annual reports, 1986.

Table 10.5. Monthly electricity costs, January 1987 (Dollars)

Sector	Residential	Commercial	Industrial
Billing Demand (kW)	-	100	1000
Consumption (kW.h)	1000	25 000	400 000
St. John's	70.01	1 769.98	22 101.29
Charlottetown	87.67	2 593.54	31 469.90
Halifax	72.61	2 261.50	23 365.48
Moncton	64.50	2 006.30	20 450.00
Montreal	42.19	1 440.30	16 745.00
Ottawa	48.80	1 272.55	18 102.55
Toronto	56.31	1 719.00	20 850.00
Winnipeg	39.42	1 042.86	11 834.51
Regina	51.00	1 614.24	20 394.24
Calgary	51.23	1 469.26	16 963.00
Edmonton	51.50	1 563.60	19 980.84
Vancouver	53.32	1 332.85	16 071.30
Whitehorse	72.30	2 280.00	-
Yellowknife	99.96	2 924.43	-

Source: Statistics Canada publication 57-203.

that the electricity price component increased more slowly than or equal to the rate of increase of the CPI for the period 1971-76. Since 1977, the electricity price index has been consistently greater than the CPI; however, the increase has been more gradual than for the oil and gas price indices.

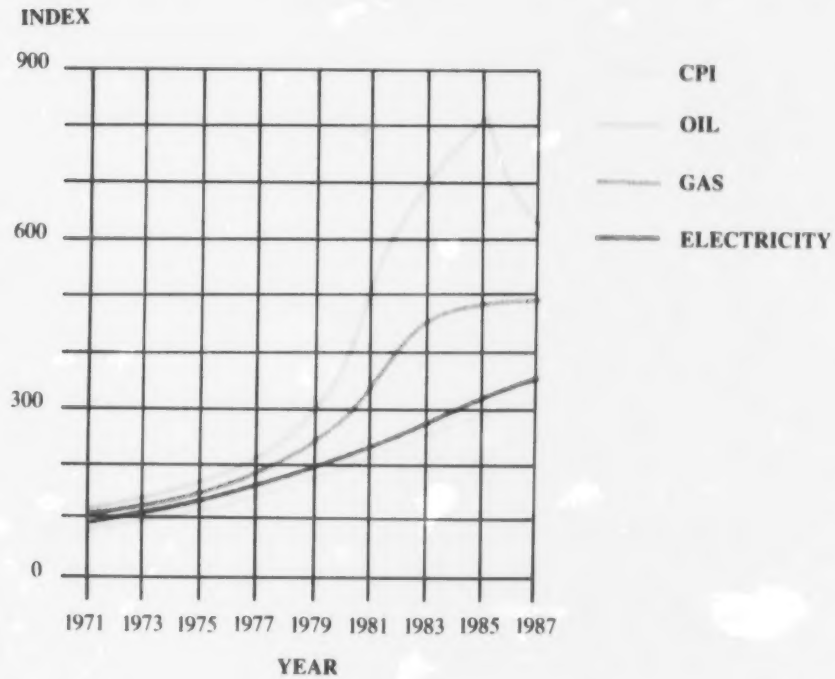
Table 10.6. Average annual rate increases, 1978-1987

	Rate Changes (%): Average of all Customer Classes									
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Newfoundland and Labrador Hydro	25.0	-	19.0	15.8	-	18.2	-	-	-1.7	0
Newfoundland Light & Power	21.2	12.4	11.8	14.6	-	12.0	-	-	8.66	3.0
Maritime Electric Co. Ltd.	13.0	-	13.1	21.4	-**	-**	-	3.7	-3.75	0
Nova Scotia Power	14.0	12.5	-(b)	36.6	-	-	-	-	-	-
N.B. Power	9.9	7.9	7.8	9.8	-	8.8	6.2	4.6	-	-
Hydro-Québec	18.7	13.7	13.3	10.6	16.3	7.3	4.0	4.0	5.4	4.9
Ontario Hydro	5.7	7.7	7.3	10.0	10.0	8.2	7.5	8.6	4.0	5.0
Manitoba Hydro	14.9	14.4	-(a)	-	-	9.5	7.9	5.0	2.8	9.7
Saskatchewan Power	3.3	8.3	7.9	16.1	-	12.6	9.2	-	7.5	7.5
Edmonton Power	8.1	-	26.0	12.0	13.2	8.0	5.0	6.7	0	3.0
TransAlta Utilities	15.6	7.5	-	13.0	4.0	15.0	-	1.7	6.1	-1.8
Alberta Power	-	-	12.3	28.9	-11.6*	2	-	-4.3	-8.6	-5.0
B.C. Hydro	13.4	5.5	7.6	2.6	20.0*	6.0	6.5	3.8	1.84	0

(a) The provincial government froze rates from 1979 until 1983.
(b) The provincial government froze rates in 1980.
* *Based on residential category.*
** *Does not reflect monthly changes to the cost of commodity and fuel adjustment charges.*

Source: Energy, Mines and Resources Canada.

Figure 10.1. Price indices, 1971-1987



A Newfoundland and Labrador Hydro lineman checks a transmission line in rural Newfoundland. NLH serves 75 000 people in approximately 200 rural communities.

11. Electricity and the Environmental Assessment Process

Most, if not all, electricity generation and transmission projects have some impact on the environment. Fossil-fuel generating stations release chemicals into the atmosphere, and dam and transmission line construction projects have an effect on local plant, animal and aquatic life. Governments, the industry and other groups in society have recognized the need to assess and reduce these impacts. For their part, federal and provincial governments have established processes that are designed to measure and mitigate the environmental consequences of electrical generation and transmission projects.

Despite differences from one jurisdiction to another in the nature of the environment and in the scale and type of project proposed, there are significant similarities in the processes developed by various provincial governments to ensure that the development of electricity generation and transmission projects does the minimum harm possible to the environment.

In most jurisdictions, the developer has initial responsibility for the environmental assessment of activities, and a lead agency (often in the department responsible for the environment) is normally appointed to review this assessment on behalf of the provincial government.

In all jurisdictions, decision-making occurs in discrete steps. Small, routine projects with no substantial or significant impacts are first screened out and allowed to proceed with a minimum loss of time and expense. The screening process is being opened to scrutiny by various means, such as the publication of lists identifying projects and their status.

Projects that may have a major adverse environmental impact are submitted for a more searching (and sometimes more visible and structured) review. Major projects could be subject to public review by an independent board or panel.

The Environmental Impact Statement (EIS) is used in most jurisdictions during the assessment of projects having a potentially major adverse environmental impact. The EIS format is similar in all jurisdictions and involves a project description, an analysis of how the project will impact on the environment, and an identification of proposed mitigating measures. It is normally proposed by the project proponent and is reviewed by the lead and other government agencies or by a public review board or panel.

Most processes involve some form of public review, but the degree of formality varies among jurisdictions from strict adherence to judicial practice to informal community meetings.

The ultimate decision-maker is usually an elected official or officials - a Cabinet minister or the entire Cabinet.

The processes in place in Canadian jurisdictions are outlined below. Some of this material is reviewed in more detail in a report produced under the auspices of the Canadian Council of Resources and Environment Ministers.[1] Since this 1985 report was completed, Manitoba and New Brunswick have introduced major changes and these are reflected in this chapter. Nova Scotia and Prince Edward Island have introduced legislation that will affect their environmental processes, but the proposed changes are not reflected in the notes below because they were not in effect at the time of writing.

[1] William J. Couch, Ph.D. (ed), *Environmental Assessment in Canada: 1985 Summary of Current Practice* (Ottawa, Canadian Council of Resource and Environment Ministers, 1985, catalogue number EM 104-4/1985).

FEDERAL PROCESS

The Federal Government's Environmental Assessment Review Process

In December 1973, Cabinet established the federal Environmental Assessment Review Process (EARP) to ensure that the environmental effects of all federal projects are assessed early in the planning process. A federal project is one initiated by a federal agency, or one that involves federal funding or federal property. Federal Crown corporations are not bound by the Cabinet decision, but they are invited to participate in the process.

Under EARP, federal departments are responsible for assessing their own projects. They conduct an initial screening to determine whether a given project will have significant environmental effects. If no such effects are perceived, the project may go ahead with appropriate monitoring by the initiating department.

If significant environmental effects are perceived, a formal review process is undertaken by an Environmental Assessment Panel created by the Minister of the Environment. The Panel is assisted in its work by the Federal Environmental Assessment Review Office. The Panel normally requires that the project sponsor prepare an EIS. If the Minister of the Environment and the initiating minister concur, the scope of the Panel may be extended to include general socioeconomic effects and the need for the project.

Public participation is an integral part of the assessment process. Any person or organization with an interest in the project is provided with an opportunity to appear before the Panel.

Once a Panel has completed its deliberations and evaluated all information on a project, it prepares a report containing its findings and recommendations. A Panel could recommend that a project not proceed, that it proceed as planned, or that it proceed subject to certain terms and conditions. The recommendations are submitted to the Minister of the Environment and the initiating minister, who must decide to whom the recommendations are directed, to what extent they should be incorporated into terms and conditions governing the project, and in what manner they are to be made public. In the event of a disagreement between the two ministers, the question may be submitted to Cabinet.

In 1987, Environment Canada released a discussion paper, which identified a number of possible changes to the federal government's process identified above.[2] These included a mandatory initial environmental evaluation for certain types of proposals and possible publishing of the results. At the time of writing this chapter, many of the concepts contained in the discussion paper were being reviewed by federal departments and agencies.

PROVINCIAL PROCESSES

British Columbia

The principal legal basis for British Columbia's energy project review process is the Utilities Commission Act, 1980. Major energy projects cannot proceed until the proponent has received either an Energy Project Certificate or a Certificate of Public Convenience and Necessity, both of which specify the terms and conditions under which the facility may be constructed and operated.

In order to obtain a Certificate, a proponent (other than a public utility) must first provide a prospectus, then an application, to an Energy Project Coordinating Committee (EPCC). This steering group is chaired by the Ministry of Energy, Mines and Petroleum Resources and includes representatives from the Ministry of Environment and Parks and a member of the British Columbia Utilities Commission (BCUC). In the application, the proponent must address environmental impacts, impact management strategies, benefit and costs, and proposals for compensation, mitigation and monitoring. The EPCC, through several inter-ministry working groups, reviews the material and formally submits it to the ministers of Environment and Parks and of Energy, Mines and Petroleum Resources, together with recommendations. Generally, the recommendations are either for a public hearing by the BCUC or exemption from provisions of the Utilities Commission Act.

If an application is referred to the BCUC, a report is sent to the two ministers once the public hearing is completed. The Minister of Energy, Mines and Petroleum Resources, with the concurrence of the Minister of Environment and Parks, then announces the Cabinet decision.

If a public utility applies for an Energy Project Certificate, the ministers may refer the application to the BCUC for review and decision. This may include holding a public hearing and may result in the issuance, directly by the Commission, of a Certificate of Public Convenience and Necessity.

Alberta

Alberta's Environmental Impact Assessment (EIA) process was established by the Land Surface Conservation and Reclamation Act of 1973. Pursuant to Section 8 of the Act, the Minister of the Environment may require a proponent of a proposed development to prepare an EIA report if he or she believes it is in the public interest to do so. The purpose of an EIA is to provide information to the public and the government to enable early identification and resolution of significant adverse effects on the environment.

The Alberta EIA process is implemented in accordance with the Alberta EIA Guidelines and administered by the Alberta Department of Environment. Most major resource developments proposed in Alberta are subject to this requirement. Major thermal and hydro generation undertakings require an EIA, and smaller projects must submit the environmental information necessary for the required approvals. In preparing an EIA, the proponent (a person, company, provincial agency or Crown corporation) must consult with the public and provide opportunities for the public to participate in the preparation and review of the EIA.

Energy projects require the approval of the Alberta Energy Resources Conservation Board (ERCB) and Alberta Environment. Consequently, Alberta Environment and the ERCB coordinate their respective information requirements and reviews of energy projects. EIAs on energy projects are filed with Alberta Environment and the ERCB as part of the application to the ERCB. The ERCB may require a public hearing to be held for a project. After the ERCB makes its decision, Alberta Environment issues detailed environmental permits and licences.

[2] Environment Canada, *Reforming Federal Environmental Assessment: A Discussion Paper* (Ottawa, Minister of Supply and Services, Canada, 1987, catalogue number EN 106-5/1987).

Saskatchewan

The Environment Assessment Act of 1980 provides for environmental impact assessments of major development projects, and exemptions may be granted by Cabinet only in cases of emergency.

The province's environmental impact assessment and review process is administered by the Saskatchewan Department of Environment and Public Safety, and projects may proceed only with the approval of the Minister of Environment and Public Safety. Proposals are screened by the department to determine whether an EIA is required and, if so, its nature and scope. If it is determined that an EIA is not required, the project may proceed subject to all other statutory requirements.

Where an EIA is required, proponents are encouraged to undertake a public participation program as early as possible so that public comments and recommendations may be considered during the preparation of the Environmental Impact Statement (EIS). Further safeguards are built into the process, such as a minimum 30-day public review of the EIS and the power given to the minister to establish a Board of Inquiry, which may hold public hearings. The final decision to approve (with or without conditions) or to refuse the proposed development rests with the minister.

Manitoba

The Manitoba Environment Act of 1988 replaces the former Clean Environment Act of 1968 and the Environmental Assessment and Review Process, adopted as provincial Cabinet policy in 1975.

The new Act requires that the planning of prospective developments, both public and private, take into consideration the interests of all affected parties. It also requires anyone planning a project that could affect the environment to register it with the Department of Environment and Workplace Safety and Health, and conduct an environmental assessment. Major projects require ministerial approval before proceeding.

Activities that would be affected by the Environment Act are described as "developments." A development can take one of three forms, which accordingly have been separated into three separate classes. Class 1 developments are essentially pollution-related. Class 2 developments are activities with significant environmental impact caused by factors other than pollution or by factors in addition to pollution. Class 3 developments are relatively few in number and involve large-scale projects such as major hydro developments, water diversions, and industrial developments.

Under the provisions of the Act, any person or organization undertaking a development proposal is required to register the development with the Department of Environment and Workplace Safety and Health at an early stage in the planning schedule. Representatives from government departments with an interest in the development prepare appropriate study guidelines for the proponent to apply in preparing an assessment. The type of assessment developed focuses on the main issues associated with the project, while keeping the review process as expeditious as possible. The public is provided with an opportunity for input at selected points of the review process, depending on the type of assessment undertaken. The final product of the process is an environmental licence with terms and conditions specific to the proposal. Alternatively, a licence to proceed could be refused on the grounds of unacceptable environmental damage.

Ontario

The Minister of the Environment is responsible for the administration of the Environmental Assessment Act, which promotes improved planning by providing for the involvement of the public and government ministries and agencies in the environmental assessment, planning and approvals process. (The environmental process in Ontario is also subject to the terms of the Consolidated Hearings Act, 1981. This summary, however, deals only with the Environmental Assessment Act, which is one of two major pieces of provincial legislation affecting the environment. Further details of the Consolidated Hearings Act may be obtained from *Environmental Assessment in Canada*[3] or from the October 1987 issue of *Canadian Environmental Law Reports*.[4])

The environment minister may, with the approval of Cabinet, exempt proponents from the application of the Environmental Assessment Act, which currently applies to the activities of provincial ministries, municipalities and conservation authorities. Only those undertakings of the private sector specifically or generically designated by regulation are subject to the Act. Proponents planning an undertaking must determine if the Act applies, and where it does not apply or where an exemption has been granted, the activity may proceed. If the Act applies, the proponent must prepare an Environmental Assessment (EA), which is reviewed by the Ministry of Environment and other

[3] William J. Couch, Ph.D., *op. cit.*

[4] *Canadian Environmental Law Reports*, New Series, Vol. 1, Part 6, October 1987.

interested provincial and federal government organizations.

The Ministry subsequently prepares its comments which, together with the EA, are released for a minimum 30-day public review. A hearing of the Environmental Assessment Board may then be requested by the reviewers, the public or the proponent. Should the minister decide that a Board hearing is not required, the minister — with the concurrence of Cabinet — will make a decision to approve, with or without conditions, or refuse the undertaking. When the minister decides to refer the matter to a Board hearing, the Board must give reasonable notice of the hearing, which is open to the public. The minister or Cabinet has 28 days to make any amendments to the Board's decision; if no amendments are made within this period, the Board's decision becomes binding.

Quebec

In Quebec, the process of environmental assessment varies depending on whether a project is in the south of the province or in a territory that is the subject of agreements with native people.

The 1972 Environment Quality Act was amended significantly in 1978 to implement an environmental impact assessment and review procedure. By regulation, this procedure applies essentially to projects in the south of the province. When a project is subject to the procedure, the proponent must submit an EIA to the Department of the Environment for an admissibility analysis and an evaluation of the environmental acceptability of the project. All projects are subject to a public consultation period, during which any citizen may ask the Minister of the Environment to hold a public hearing. Citizens can thus voice their views before the project is referred to Cabinet for acceptance or refusal.

In the northern Quebec territories, the provincial government has implemented a particular procedure to assess and review the environmental and social impacts of a given project. A distinctive feature of this procedure is the use of bipartite or tripartite committees on which native people are always represented. These committees advise the Deputy Minister of the Environment throughout the various stages of the authorization process. This procedure, which was incorporated into the Environment Quality Act, stemmed from the James Bay and Northern Quebec Agreement (1975) and the Northeastern Quebec Agreement (1978).

New Brunswick

New Brunswick's Regulation on Environmental Impact Assessment was promulgated in July 1987, to provide a legislative framework for environmental planning, including opportunities for public involvement. The Regulation, which replaced the province's 1975 Policy on Environmental Assessment, is designed to identify the environmental impacts associated with development proposals, in advance of their implementation.

Under the Regulation, individuals, companies or public agencies proposing certain types of projects are required to register information about the project with the Minister of Municipal Affairs and Environment at an early stage in the planning cycle. The minister then screens the proposal to determine whether it is likely to have significant environmental impacts, including both socio-economic and biophysical effects.

If it appears that the project's impacts are likely to be significant, the minister will inform the proponent that an EIA is required, and staff from the Department of Municipal Affairs and Environment will work with the proponent in preparing initial draft guidelines for the EIA Study. A Review Committee, consisting of technical specialists from government agencies potentially affected by the proposal, is appointed by the minister to formulate draft guidelines for the Study. These draft guidelines, which identify the important environmental issues to be addressed, may then be issued by the minister for public comment, and any interested party may provide written comments to the minister.

The principal objective of the EIA Study is to predict the project's impacts, should it proceed. Information gathered during the study is compiled in a draft Environmental Impact Assessment Report, which is then carefully examined by the Review Committee. If, on the advice of the Committee, the minister is satisfied that the report adequately addresses all aspects of the guidelines, a second and more comprehensive opportunity for public involvement begins. A summary of the report, comments of the Review Committee, and full copies of the final report are released for public review and comment.

A public meeting to discuss the EIA takes place. Thereafter, the minister reviews the study and public comments, and then recommends to the Lieutenant-Governor in Council whether or not the project should proceed.

Nova Scotia

The legal bases for environmental impact assessment in Nova Scotia are the Environmental Protection Act and the Water Act.

The Nova Scotia Department of the Environment (NSDOE) is responsible for screening all projects submitted and advising the minister on those that may have a significant and adverse

environmental impact. After reviewing NSDOE's advice, as well as any public concern expressed, the minister decides whether a project requires an EIA. Where it is decided one is required, the proponent prepares a draft EIA and submits it to NSDOE. The department and other interested provincial and federal agencies review the EIA, and the NSDOE then recommends to the minister whether the project should be approved, with or without conditions, or refused.

The public may participate in the process through a number of mechanisms. The minister, based on NSDOE recommendations and the views of the public, decides whether the project should proceed and, if so, under what conditions.

Prince Edward Island

In 1973, P.E.I.'s Executive Council directed provincial departments and agencies to screen all energy developments for potentially significant adverse environmental impacts.

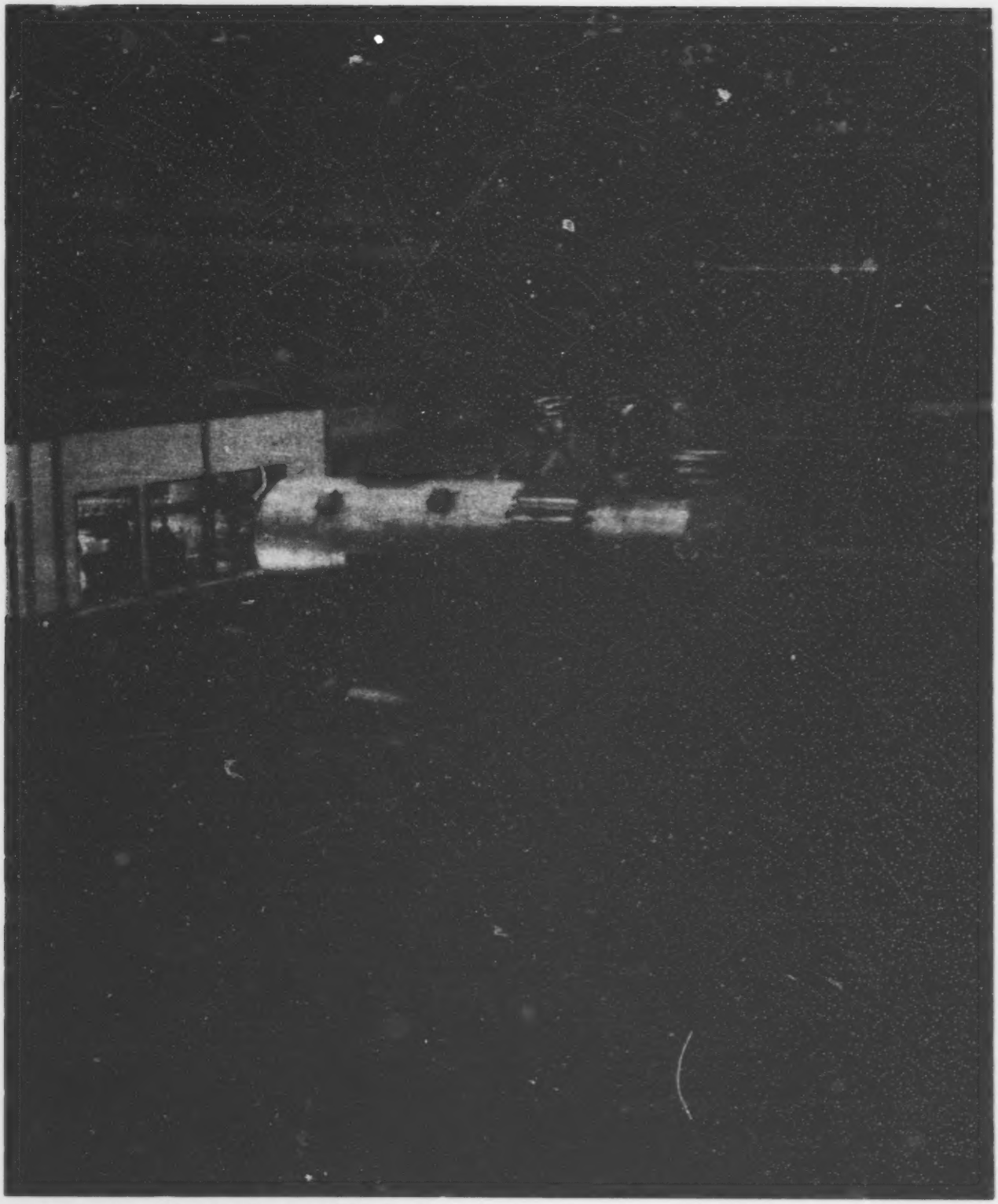
With respect to utilities, the Public Utilities Commission may issue project-specific guidelines to the proponent for the preparation of an EIS, if it believes that the project may adversely affect the environment. A copy of the EIS is then sent by the Commission to the Executive Council for its consideration. The Council may make a decision on the evidence available or it may determine that the public interest requires public hearings to be held in the locality affected by the project. After the public hearings, the Commission examines the evidence and issues its findings to the Executive Council.

Newfoundland

The province's environmental assessment process operates under the authority of the Environmental Assessment Act of 1980, which is administered by the Department of Environment.

The preliminary design of any undertaking that may have a significant adverse environmental impact must be registered with the Minister of Environment. The minister, on the advice of the department, decides whether or not an EIS is required. If an EIS is not required, the undertaking may proceed subject to other relevant acts or regulations.

Where an EIS is required, it is prepared by the proponent; the minister then makes it available for public review and comment. Should strong public interest be expressed, the minister may recommend to Cabinet that an Environmental Assessment Board be appointed to conduct public hearings. The minister makes the Board's report public, delivers copies to Cabinet, and subsequently recommends to Cabinet whether the undertaking should be permitted to proceed, with or without conditions, or whether permission should be refused.



An interior view of Newfoundland and Labrador Hydro's Holyrood thermal generating station, showing the three generating units. Work is now underway to uprate two of the units from 150 MW to 175 MW each.

12. Electricity Outlook

Forecasting electricity demand has become a difficult task in recent years. This is largely a result of the economic dislocation caused by rapidly rising energy prices, particularly between 1975-77 and 1980-82. The effects of higher energy prices have been felt globally, and adjustments have been made worldwide in the amount, types, and uses of energy. The collapse of world oil prices in 1986 has added to the uncertainty. Adjustments in energy-use patterns continue to make economic forecasting difficult, and this economic uncertainty, in turn, leads to uncertainty about future electricity demand.

Despite this uncertainty, forecasts of electricity demand are essential to ensure that sufficient generating capacity is available when it is needed. The long lead time in the construction of new generating facilities makes it necessary for utilities to calculate future demand many years in advance. This chapter presents projections of electrical energy demand, peak demand, generating capacity, electricity generation, and fuel requirements for the period 1987-2005. Capital expenditures for the period 1987-97 are also summarized.

FORECASTS OF ENERGY DEMAND

Because economic growth and population growth over the next 18 years are expected to be significantly lower than the previous 27-year period, electricity growth is also expected to be lower. Table 12.1 summarizes electricity demand forecasts for the ten provinces and two territories during the period 1987-2005. The projections of electrical energy demand within the service areas of the major utilities were prepared by the utilities and provided to Energy, Mines and Resources Canada (EMR) in February 1988. Electricity demand for smaller utilities and industrial establishments was projected by the National Energy Board. The Electrical Energy Branch of EMR combined these two sources of forecasts and produced an overall electricity demand forecast for the provinces and territories. Table 12.1 indicates that Alberta is expected to have the highest electricity demand growth, with an average growth rate of 3.4 per cent during the period 1987-2005, followed by Nova Scotia at 3.0 per cent. Ontario's demand is expected to be 2.1 per cent, which is the national average, and Quebec's is expected to grow at a rate of only 1.7 per cent annually.

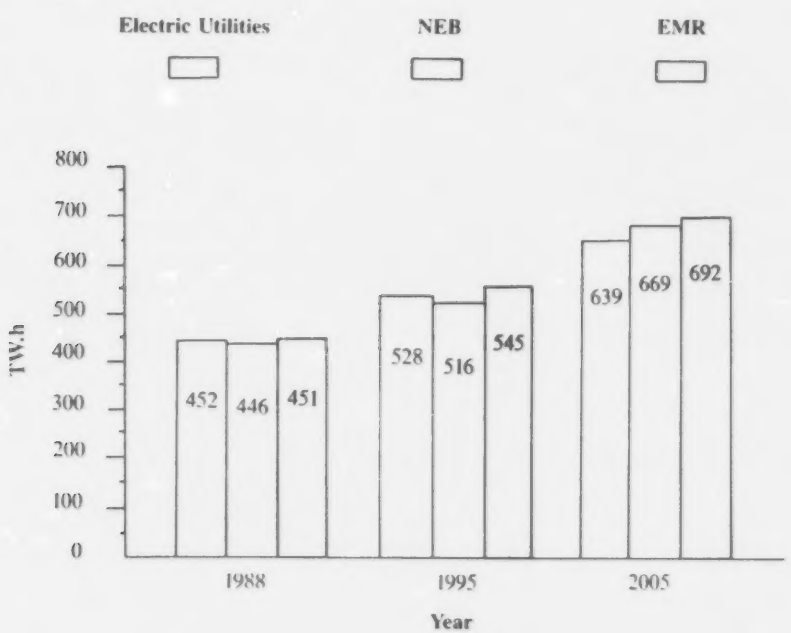
Figure 12.1 illustrates various forecasts for overall electricity demand in Canada. Included for comparison are the latest forecasts derived from EMR's Interfuel Substitution Demand Model, the National Energy Board Model, and forecasts provided mainly by the major electric utilities. The utilities' projection of electricity demand for the next 18 years appears to be on the low side at 2.1 per cent per year, compared with the NEB's 2.4 per cent, and EMR's 2.6 per cent. All three forecasts, however, are substantially lower than the 5.2 per cent achieved during the period 1960-1987.

Table 12.1. Forecasts of domestic energy demand

	1987	1990	1995	2000	2005	Average Annual Growth Rate 1987-2005
			(GW.h)			(%)
Nfld.	9 697	10 647	11 485	12 359	13 243	1.8
P.E.I.	647	709	771	828	889	1.8
N.S.	8 326	9 798	11 226	12 636	14 127	3.0
N.B.	12 376	13 832	16 003	17 835	19 531	2.6
Quebec	158 196	161 099	183 350	200 350	214 748	1.7
Ontario	132 [illegible]	142 074	159 927	175 290	191 160	2.1
Man.	1[illegible]	17 792	19 939	21 748	23 814	2.3
Sask.	1[illegible]	13 553	15 528	17 311	19 190	2.4
Alta.	36 [illegible]	39 873	48 698	59 928	67 190	3.4
B.C.	50 934	55 506	60 508	66 455	73 944	2.1
Yukon	432	474	523	577	638	2.2
N.W.T.	467	526	529	552	570	1.1
Canada	438 150	465 883	528 487	585 869	639 044	2.1

Source: Canadian electric utilities, and National Energy Board.

Figure 12.1. Comparison of electricity demand forecasts



FORECASTS OF PEAK DEMAND

Table 12.2 reports forecast peak demand growth for the provinces and territories, as projected by the major electric utilities for the period 1987-2005. With the exception of Ontario, Manitoba, and the Yukon, all other provinces and the Northwest Territories appear to have a larger growth rate in peak demand than in energy demand. This suggests that the load factor for Ontario, Manitoba, and the Yukon will improve during this period, while the load factor for the remaining provinces and territory will decrease. The load factor for Canada as a whole is expected to decrease, from 67 per cent in 1987 to about 65 per cent by the year 2005.

FORECASTS OF GENERATING CAPACITY

To meet the forecast growth in electricity demand shown in Tables 12.1 and 12.2, total installed generating capacity in Canada is expected to increase at an average

Table 12.2. Forecasts of domestic peak demand

	1987	1990	1995	2000	2005	Average Annual Growth Rate 1987-2005
			(MW)			(%)
Nfld.	1 758	1 858	2 067	2 283	2 484	1.9
P.E.I.	105	116	126	135	159	2.3
N.S.	1 484	1 818	2 097	2 406	2 734	3.5
N.B.	2 178	2 619	3 048	3 413	3 713	3.0
Quebec	26 717	28 749	32 893	36 263	39 143	2.1
Ontario	22 418	24 397	26 641	28 954	31 376	1.9
Man.	3 247	3 498	3 927	4 285	4 709	2.1
Sask.	2 252	2 509	2 874	3 179	3 519	2.5
Alta.	5 525	6 242	7 478	9 104	10 154	3.5
B.C.	8 514	9 546	10 556	11 726	13 176	2.5
Yukon	69	72	79	88	97	1.9
N.W.T.	89	113	117	122	126	2.0
Canada	74 356	81 537	91 903	101 958	111 390	2.3

Source: Canadian electric utilities, and National Energy Board.

annual rate of 1.4 per cent, from almost 101 000 MW at the end of 1987 to about 129 000 MW by the end of 2005. This level of growth is significantly lower than energy and peak demand growth, reflecting the current excess capacity situation in most of the provinces. Forecasts of installed capacity by province are summarized in Table 12.3, and forecasts of installed capacity by fuel type for Canada as a whole are displayed in Table 12.4.

The largest share of total Canadian capacity over the next 18 years will continue to be hydro, increasing slightly from 57 per cent of total capacity in 1987, to 59 per cent by the year 2005. Nuclear generating capacity, as a share of total capacity, will remain relatively stable at 12 per cent through the period, while coal-fired capacity is expected to increase moderately, from 17 per cent in 1987 to about 19 per cent in 2005. The capacity share of natural gas is expected to decrease slightly, from 5 per cent to 4 per cent for the period 1987-2005. The share of oil-fired capacity is also expected to decline, from 8 per cent in 1987 to 6 per cent by 2005. Thus coal, nuclear, and hydro will continue to account for most of the electricity generated in Canada. In 1987, these three sources accounted for 87 per cent of total capacity, and this percentage is expected to

Table 12.3. Forecasts of installed generating capacity by province

	1987	1990	1995	2000	2005	Average Annual Growth Rate 1987-2005
			(MW)			(%)
Nfld.	7 402	7 482	8 297	8 306	8 419	0.7
P.E.I.	122	124	124	124	124	0.1
N.S.	2 346	2 055	2 777	3 105	3 565	2.4
N.B.	3 490	3 430	3 762	4 397	4 797	1.8
Quebec	27 644	28 814	30 905	36 087	39 604	2.0
Ontario	32 123	31 927	34 405	34 984	35 127	0.5
Man.	4 137	4 347	5 321	5 707	6 357	2.4
Sask.	2 948	2 826	3 311	3 673	4 103	1.9
Alta.	7 605	7 622	8 618	10 281	11 915	2.5
B.C.	12 508	12 560	12 555	12 855	14 570	0.9
Yukon	123	123	126	128	132	0.4
N.W.T.	190	189	190	193	194	0.1
Canada	100 638	101 599	110 511	119 930	128 907	1.4

Source: Canadian electric utilities, and National Energy Board.

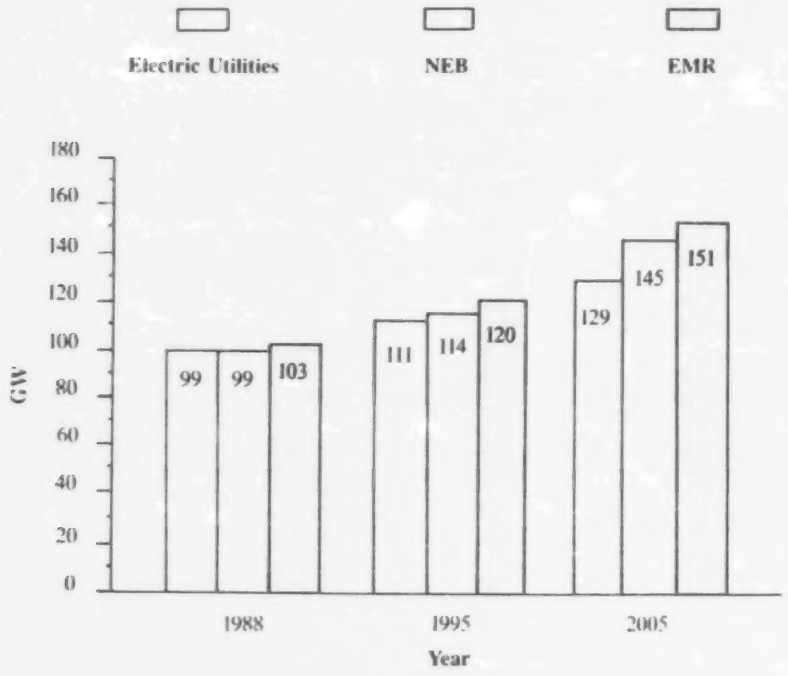
Table 12.4. Forecasts of installed generating capacity by fuel type in Canada

	1987	1990	1995	2000	2005
			(MW)		
Coal	17 420	17 773	20 070	22 030	24 632
Oil	7 860	7 286	7 322	7 543	7 649
Natural gas	5 157	3 459	3 829	4 520	4 962
Nuclear	11 928	13 857	15 619	15 597	15 597
Hydro	57 731*	58 736	63 113	69 632	75 444
Other	542	488	558	608	623
Total	100 638	101 599	110 511	119 930	128 907

* *Includes tidal power.*

Source: Canadian electric utilities, and National Energy Board.

Figure 12.2. Comparison of generating capacity forecasts



increase slightly to 90 per cent by the year 2005.

Figure 12.2 compares various forecasts of total generating capacity in Canada for the period 1988-2005. Again, the electric utilities' forecasts are on the low side. Both EMR and the NEB have projected larger generation requirements. Between 1987 and 2005, the electric utilities have projected new capacity additions of about 28 GW, or about 1650 MW per year. The NEB projects capacity additions of 44 GW, or about 2590 MW per year; EMR projects new additions of 50 GW, or about 2940 MW per year. EMR's projections are significantly higher than the electric utilities' own projections.

FORECASTS OF ELECTRICITY GENERATION

Utility forecasts of electricity generation by province for the period 1987-2005 are presented in Table 12.5. As the data indicate, Quebec is expected to remain the largest electricity producer in

Table 12.5. Utility forecasts of electricity generation by province

	1987	1990	1995	2000	2005	Average Annual Growth Rate 1987-2005
			(GW.h)			(%)
Nfld.	40 090	39 943	39 932	40 549	41 558	0.2
P.E.I.	164	225	225	225	225	1.8
N.S.	7 749	9 619	11 053	12 463	13 954	3.3
N.B.	12 493	14 074	20 265	23 986	26 236	4.2
Quebec	156 952	154 843	174 714	191 458	206 054	1.5
Ontario	131 582	145 770	166 517	179 450	194 340	2.2
Man.	19 902	20 030	23 399	26 610	25 069	1.3
Sask.	12 440	13 234	14 982	16 889	18 733	2.3
Alta.	36 770	39 873	48 663	59 928	67 190	3.4
B.C.	63 067	54 145	56 790	57 741	66 471	0.3
Yukon	432	474	523	577	638	2.2
N.W.T.	467	573	576	602	622	1.6
Canada	482 108	493 723	557 439	610 478	660 880	1.8

Source: Canadian electric utilities, and National Energy Board.

Canada, followed by Ontario. Alberta is expected to overtake British Columbia as the third largest electricity-producing province by the year 2000.

Utility forecasts of electricity generation by principal fuel type for Canada are summarized in Table 12.6. The data suggest that hydro-based generation will continue to be the most important source of electric energy in Canada, although its share of total electricity production will decline from 65 per cent in 1987 to about 58 per cent in 2005. Coal-fired production is expected to decrease, in both quantity and market share, between 1987 and 1990, and then steadily increase to about 22 per cent of total electricity generation by the year 2005. The 1987-90 decrease is due mainly to Ontario Hydro's plan to reduce its coal-fired generation from 32 TW.h in 1987 to only 14 TW.h by 1990. This substantial reduction will be offset by increasing nuclear production from the Darlington nuclear station.

Even though falling world oil prices in recent years have provided electric utilities with an economic incentive to utilize their existing oil-fired stations in the short term, oil prices are not expected to remain low for a long period of time. In the long term, oil-fired stations will continue to be used mainly as peaking capacity and to serve energy demand in remote locations. Beyond 1990, the use of oil in electricity generation is expected to decrease with the overall increase in demand. By the year 2005, the share of electricity generated from oil is expected to be 1.4 per cent of total electricity generation, compared with 1.8 per cent in 1987. It is expected that natural gas will slightly increase its share in electricity generation, from about 1.5 per cent in 1987 to about 2.2 per cent by 2005. The increased use of natural gas for electricity generation will come mainly from industrial establishments in Ontario and major utilities in Alberta. Nuclear generation is expected to reach a peak in both quantity and market share by the year 1995. The nuclear share of electricity generation is expected to increase from 15 per cent in 1987 to a peak of about 21 per cent in 1995, and then decline to about 17 per cent by the year 2005. A comparison of various electricity generation forecasts is shown in Figure 12.3.

FORECASTS OF FUEL REQUIREMENTS

Forecast fuel requirements are reported in Table 12.7. They are based on the forecasts of energy generation given in Table 12.6.

Coal consumption for electricity generation is expected to decrease significantly from about 43 million tonnes in 1987 to 37 million tonnes in 1990, because of the substantial reduction in electricity generation from coal-fired stations in Ontario. Nevertheless, the use of coal will increase to about 45 million tonnes in 1995 and will reach 69 million tonnes by the year 2005. The major increase in coal use will be in Alberta, New Brunswick, and Nova Scotia. Ontario is expected to increase its use of coal from 5.1 million tonnes in 1995 to about 16 million tonnes by the year 2005.

Oil consumption is expected to increase moderately from 2.1 to 2.3 million cubic metres (or 14 million barrels) between 1987 and 1990, and then to decline gradually to about 1.9 million cubic metres (or 12 million barrels) by the year 2005. Oil will be used primarily for peaking purposes and in remote locations.

Over the forecast period, 1987 to 2005, the use of natural gas for electricity generation is projected to increase from 2979 million cubic metres to 6051 million cubic metres. This increase is larger than those forecast for coal, oil, and uranium. Major industrial establishments, mainly in Alberta and Ontario, are the largest users of

Table 12.6. Forecasts of electricity generation by fuel type in Canada

	1987	1990	1995	2000	2005
			(GW.h)		
Coal	78 280	63 493	80 318	115 222	143 061
Oil	8 666	10 887	9 586	9 486	9 053
Natural gas	7 095	8 104	10 429	12 327	14 512
Nuclear	72 888	98 859	116 297	109 030	109 030
Hydro	313 189	301 024	337 983	360 703	381 464
Other	1 990	2 356	2 826	3 710	3 760
Total	482 108	493 723	557 439	610 478	660 880

Source: Canadian electric utilities, and National Energy Board.

Figure 12.3. Comparison of electricity generation forecasts

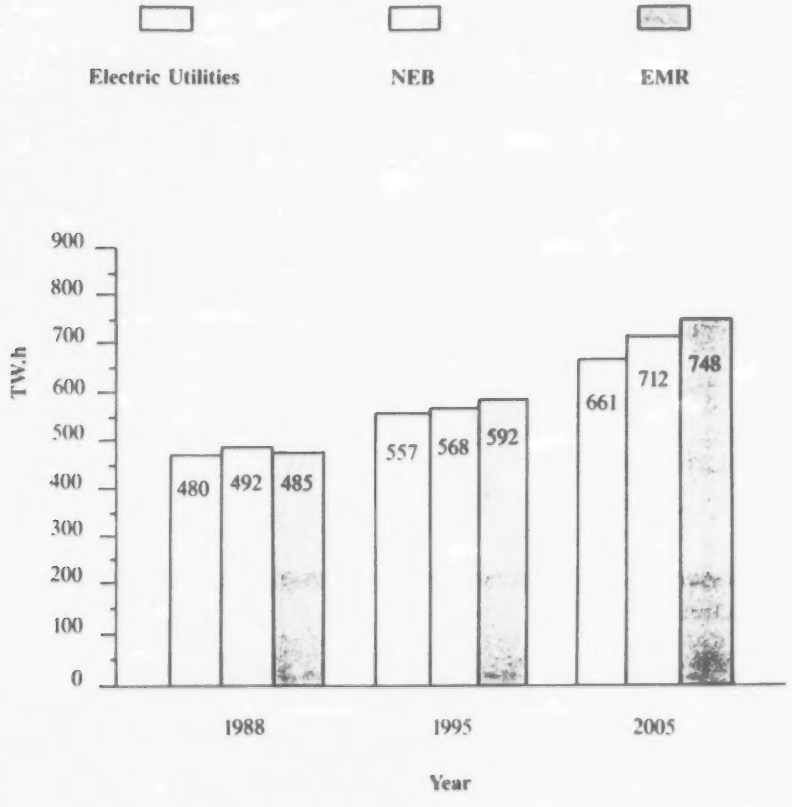


Table 12.7. Fuels required for electricity generation

	Coal (10^3 tonnes)	Oil (m^3)	Natural Gas ($10^6 m^3$)	Uranium (tonnes)
1987	42 500	2 053 387	2 979	1 306
1990	36 688	2 336 912	3 325	1 846
1995	44 672	2 055 659	4 362	2 068
2000	59 223	2 020 335	5 917	1 933
2005	68 603	1 902 529	6 051	1 933

Note: 1 m^3 oil = 6.3 bbls
1 m^3 gas = 35.5 ft^3
1 tonne = 1000 kg

Source: Canadian electric utilities, and National Energy Board.

natural gas for electricity generation; their share accounted for about 84 per cent in 1987, and is expected to be 63 per cent by the year 2005. The major electric utilities in Alberta also use a substantial amount of natural gas for electricity generation; their share is expected to increase from 16 per cent to 37 per cent over the period 1987-2005.

With nuclear energy becoming an increasingly important component of the Canadian electricity supply, the use of uranium for electricity generation is expected to increase substantially from 1306 tonnes in 1987 to 2068 tonnes in 1995; it will then stabilize at 1933 tonnes through to the year 2005.

FORECASTS OF CAPITAL EXPENDITURES

Table 12.8 summarizes capital expenditures for major utilities in each of the provinces and territories for the period 1988-97. Over the next ten years, major utilities in Canada are expected to invest about $95 billion in facilities. Quebec will be the largest investor with $39 billion, accounting for about 41 per cent of the total. Ontario is expected to invest about $29 billion in electrical energy, or about 30 per cent of Canada's total. Most of this expenditure will be for the Darlington nuclear station.

Alberta ranks third in projected capital investment, with $7 billion or 7 per cent of the total. This investment will mainly be in coal-fired stations. Manitoba is expected to spend more than $5 billion in capital investment, accounting for about 6 per cent of Canada's total.

The electric utilities' capital investments by function are presented in Table 12.9. It is expected that generating facilities will account for 49 per cent of the total for the period 1988-1997, transmission 25 per cent, distribution 14 per

Table 12.8. Capital expenditures for major electric utilities, 1987-1997

	1987*	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	(millions of current dollars)										
Newfoundland	86	172	164	204	168	137	142	222	348	524	644
Prince Edward Island	11	11	22	12	11	15	12	10	11	15	16
Nova Scotia	117	133	221	270	235	296	312	322	206	208	274
New Brunswick	86	131	175	312	484	316	376	419	431	570	400
Quebec	1 688	2 240	2 460	2 850	3 308	3 635	3 590	4 782	5 596	4 884	5 548
Ontario	2 638	2 900	2 700	2 500	2 300	2 200	2 500	2 900	3 700	3 600	3 200
Manitoba	319	459	453	439	405	282	290	394	523	881	1 105
Saskatchewan	134	210	341	327	348	220	248	352	410	334	350
Alberta	488	736	683	573	618	493	579	717	631	754	813
British Columbia	142	238	193	175	154	186	258	270	358	469	611
Yukon	3	2	2	2	2	2	2	2	2	2	2
Northwest Territories	14	27	31	12	10	6	85	9	9	9	9
Canada	5 726	7 259	7 445	7 676	8 043	7 788	8 394	10 399	12 225	12 250	12 972

** Actual data*

Source: Canadian electric utilities.

Table 12.9. Capital expenditures by function, 1987-1997

	1987*	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	(millions of current dollars)										
Generation	2 644	3 270	3 252	3 515	3 665	3 673	4 031	5 227	6 358	6 723	6 715
Transmission	1 140	1 876	2 116	1 985	2 048	1 841	1 882	2 602	3 179	2 622	3 186
Distribution	1 063	1 188	1 154	1 170	1 202	1 320	1 335	1 382	1 467	1 551	1 591
Other	879	925	923	1 006	1 128	954	1 146	1 178	1 221	1 354	1 480
Total	5 726	7 259	7 445	7 676	8 043	7 788	8 394	10 399	12 225	12 250	12 972

** Actual data*

Source: Canadian electric utilities.

cent, and other facilities 12 per cent.

FORECASTS OF ELECTRICITY EXPORTS TO THE UNITED STATES

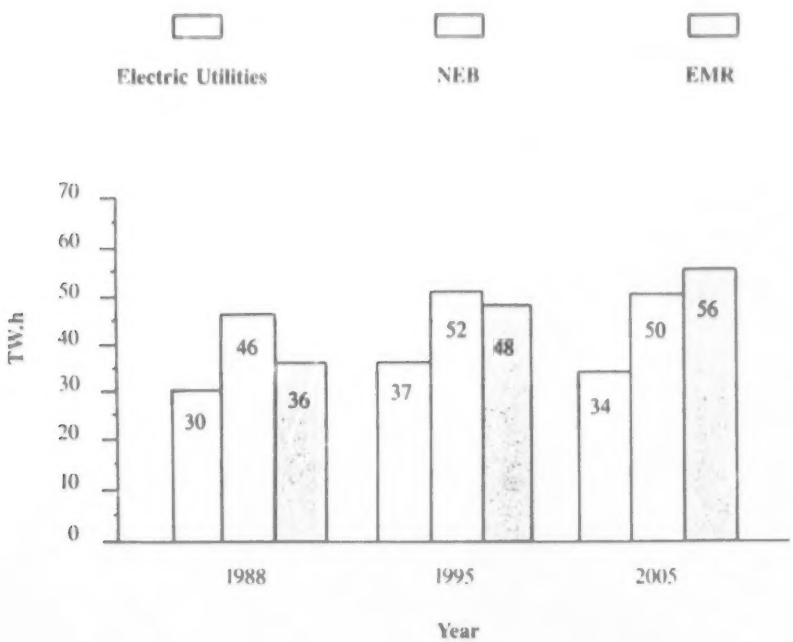
Canada and the United States enjoy essentially free trade in electricity: there is little direct government involvement in the contracting process, there are no tariffs, and there is a minimum of regulation. Table 12.10 reports projected electricity exports to the United States by province for the period 1987-2005. A comparison of electricity export forecasts is shown in Figure 12.4.

Table 12.10. Electricity exports to the United States

	1987	1990	1995	2000	2005
			(GW.h)		
New Brunswick	5 910	6 431	4 429	6 182	6 727
Quebec	16 400	15 980	19 515	18 184	17 805
Ontario	7 194	6 016	9 500	8 500	8 000
Manitoba	3 314	2 238	3 460	4 862	1 255
Saskatchewan	55	88	88	88	88
British Columbia	12 486	327	327	327	327
Canada	45 359	30 992	37 319	38 143	34 202

Source: Canadian electric utilities.

Figure 12.4. Comparison of electricity export forecasts



13. Hydroelectric Power Potential in Canada

INTRODUCTION

The harnessing of water power to generate electricity in Canada dates back to 1882, when a generating facility was installed at Chaudière Falls on the Ottawa River to provide electric lighting for a local sawmill.

With the establishment of the first Canadian commercial electric power company in Pembroke, Ontario, in 1884, the country's vast hydraulic resources immediately assumed new significance and, by 1890, electricity generated from water power was being distributed in a number of towns in Quebec and Ontario.

The subsequent development of hydroelectric power was facilitated by significant technical advances that took place around the turn of the century. Alternating current displaced direct current as the medium for power transmission, and the development of the hydraulic speed governor made parallel generation and integrated power systems possible. Developments in protection and control technology improved system reliability and safety. And long-distance transmission became possible, following the development of the electric transformer.

By 1900, every province except Prince Edward Island and Saskatchewan could boast of hydroelectric plants. These were modest in size, however; only Quebec, Ontario, and Nova Scotia had total capacities exceeding 10 MW. Canada's total installed hydraulic capacity at that time was 133 MW. By 1910, it had increased more than fivefold to 700 MW as electric power reached more urban centres.

The mineral and pulp and paper industries accounted for most of the installed generating capacity between 1910 and 1920, but new uses for electrical energy were appearing, such as for gold dredging in the Yukon and irrigation in British Columbia. By 1920, Canada's total hydroelectric generating capacity had reached almost 2000 MW. Although a few private industries and municipalities still chose to produce power for their own use, the desire to capitalize on economies of scale now began to encourage the development of large generating and distribution networks operated as public utilities.

By 1930, total Canadian generating capacity had more than doubled to 4700 MW. The Depression of the 1930s did not affect the electric power industry as much as it did other industries in Canada, but generally poor economic conditions accompanied by reduced demand resulted in a reduction in the installation rate during the period 1935-39. By the outbreak of World War II, Canada's generating capacity had grown to about 6700 MW, with the pulp and paper industry alone consuming more than 40 per cent of all energy generated.

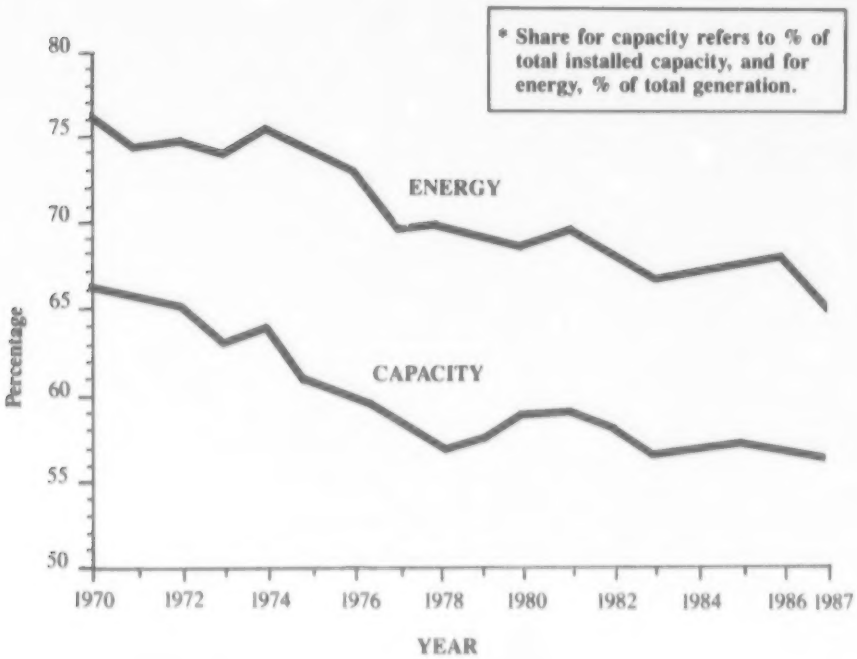
After the war, electricity demand continued to grow steadily. In 1950,

Table 13.1. Hydroelectric capacity and energy, 1970-1987

Year	Total (MW)	Hydro (MW)	Hydro (%)	Total (GW.h)	Hydro (GW.h)	Hydro (%)
1970	42 826	28 298	66.1	204 723	156 709	76.5
1971	46 678	30 601	65.6	215 064	160 412	74.6
1972	49 948	32 517	65.1	237 408	177 892	74.9
1973	54 271	34 266	63.1	262 139	192 868	73.6
1974	57 480	36 779	64.0	279 038	210 227	75.3
1975	61 352	37 282	60.8	273 392	202 396	74.0
1976	65 993	39 488	59.8	293 367	213 049	72.6
1977	70 575	40 810	57.8	316 549	220 150	69.5
1978	73 918	41 898	56.7	335 654	234 034	69.7
1979	77 228	44 009	57.0	352 304	243 041	69.0
1980	81 599	47 770	58.5	367 306	251 217	68.4
1981	83 308	49 216	59.1	377 622	262 253	69.4
1982	85 511	50 007	58.5	375 449	255 136	68.0
1983	89 492	51 274	57.3	395 005	262 862	66.5
1984	95 189	54 949	57.7	424 608	283 138	66.7
1985	97 020	57 711	59.5	447 182	301 250	67.4
1986	99 809	57 711	57.8	455 795	307 593	67.5
1987	100 638	57 711	57.3	482 108	313 159	65.0

Source: Energy, Mines and Resources Canada.

Figure 13.1. Hydroelectric capacity and energy shares *



total generating capacity in Canada was about 9800 MW, 91 per cent of which was provided from hydraulic sources. By 1970, total capacity had jumped to almost 43 000 MW, although the hydro share had fallen to 66.1 per cent. By 1980, capacity had doubled to 81 599 MW, and hydro's share had again fallen — to 58.5 per cent. This share has been more or less constant ever since. In 1987, total Canadian capacity was slightly more than 100 000 MW, and hydro's share was 57.3 per cent (see Table 13.1 and Figure 13.1).

HYDROELECTRIC POTENTIAL

Today, there is still a large amount of undeveloped hydroelectric potential in Canada. Although much of this is unlikely to be developed due to the remoteness of the sites, the physical difficulty of the terrain, or because of environmental concerns, it is anticipated that a significant amount will be developed over the next 20 to 25 years. The provinces of Quebec, British Columbia, Manitoba, and Newfoundland

Table 13.2. Hydroelectric capacity in Canada, 1987

Province or Territory	In-Operation and Under Construction	Remaining Potential		
		Gross	Identified	Planning
	(MW)			
Newfoundland	6 652	5 201	4 623	4 623
Prince Edward Island	-	-	-	-
Nova Scotia	403	8 499	8 499	0
New Brunswick	903	780	440	440
Quebec	28 805	70 529	39 313	17 912
Ontario	7 807	12 387	4 238	2 911
Manitoba	4 921	8 190	5 090	5 090
Saskatchewan	830	2 189	935	935
Alberta	734	18 813	9 762	1 923
British Columbia	10 848	31 513	16 544	10 255
Yukon	82	11 699	10 938	3 088
Northwest Territories	50	9 224	9 196	2 446
Canada	62 035	179 024	109 578	49 623

Source: Canadian electrical utilities and Energy, Mines and Resources Canada.

account for most of the remaining river potential. Tidal resources are located in Nova Scotia, Quebec, and British Columbia.

Estimates of the remaining undeveloped hydro potential can be divided into three categories (see Table 13.2). The *gross remaining potential*, some 179 000 MW, is the estimated resource that remains undeveloped. Thus, including the sites now in-operation or under construction (about 62 000 MW), Canada's total hydroelectric resource is estimated to be some 241 000 MW. The *identified potential* consists of sites for which future development has been identified as technically feasible. This category totals about 110 000 MW and may include sites that are unlikely to be developed due to unfavourable economics or overriding environmental considerations. Finally, the *planning potential*, about 50 000 MW, comprises sites that are considered to be likely candidates for future development. Approximately 20 000 MW of this planning potential falls into the low-head (less than 40 m) category.

Estimates of the total gross, identified, and planning potential in Canada, as well as a listing of all the sites in each category and their capacity factors, are provided in Appendix C. Research on the assessment of Canada's remaining hydroelectric potential has not been carried out in depth in all provinces; the data provided in Appendix C should therefore be regarded as no more than preliminary estimates.

As shown in Table 13.2, British Columbia, Manitoba, Quebec, Newfoundland, and the two territories have large remaining hydroelectric river resources. Alberta and Saskatchewan have relatively modest remaining potential. Nova Scotia, New Brunswick, and Ontario have already developed the major portions of their hydroelectric river resources, and Prince Edward Island is unique in possessing virtually no such resources.

The most feasible Canadian tidal power resource is in the Bay of Fundy, with a total potential generating capacity of 8400 MW, at three sites (Minas Basin - 5338 MW, Cumberland Basin - 1428 MW, and Shepody Bay - 1643 MW). Of these sites, Cumberland Basin lies between New Brunswick and Nova Scotia; the others are in Nova Scotia. The tidal resource at Ungava Bay in Quebec is estimated to be 26 000 MW, although the distance from Quebec's load centres makes the Ungava potential unlikely to be developed in the foreseeable future. British Columbia's tidal resources are estimated at 716 MW (Observatory Inlet - 662 MW, and Sechelt Inlet - 54 MW). As noted above, the only existing tidal power installation in North America is the 20-MW Annapolis station in Nova Scotia.

Ontario Hydro researchers demonstrate the use of a "fish pulsar" in repelling shad. Ontario Hydro pioneered the design, which uses sound to guide fish away from water intakes to areas of safe passage.

A Hydro-Québec employee carries out line maintenance high above the St. Lawrence River near Ile d'Orléans.

APPENDIX A

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Table A1. Installed capacity and electrical energy consumption in Canada, 1920-1987

Year	Installed Capacity					Electrical Energy Consumption	Average Demand	Peak Demand	Reserve Margin		Load Factor
	Thermal										
	Conventional	Nuclear	Sub-Total	Hydro	Total						
	(MW)					(GW.h) (a)	(MW) (b)	(MW) (c)	(MW) (d)	(%)	(%) (e)
1920	300	-	300	1 700	2 000	-	-	-	-	-	-
1930	400	-	400	4 300	4 700	19 468	2 222	-	-	-	-
1940	500	-	500	6 200	6 700	33 062	3 774	-	-	-	-
1950	900	-	900	8 900	9 800	55 037	6 283	-	-	-	-
1955	2 100	-	2 100	12 600	14 700	81 000	9 247	12 536	2 164	17	74
1960	4 392	-	4 392	18 657	23 049	109 302	12 477	17 264	5 785	34	72
1965	7 557	20	7 577	21 771	29 348	144 165	16 457	24 167	5 181	21	68
1970	14 287	240	14 527	28 298	42 826	202 337	23 098	34 592	8 234	24	67
1975	21 404	2 666	24 070	37 282	61 352	265 955	30 360	46 187	15 165	33	66
1976	23 039	3 466	26 505	39 488	65 993	284 829	32 515	49 527	16 456	33	66
1977	24 699	5 066	29 765	40 810	70 575	299 673	34 209	52 001	18 574	36	66
1978	26 154	5 866	32 020	41 898	73 918	316 435	36 123	54 106	19 812	37	67
1979	27 353	5 866	33 219	44 009	77 228	323 465	36 925	55 699	21 529	39	66
1980	27 853	5 866	33 719	47 919	81 638	340 069	38 821	59 170	22 464	38	66
1981	28 493	5 600	34 093	49 216	83 308	346 333	39 536	59 237	24 071	41	67
1982	28 957	6 547	35 504	50 007	85 511	345 115	39 397	62 417	23 094	37	63
1983	30 447	7 771	38 218	51 274	89 492	359 838	41 077	66 866	22 626	34	61
1984r	30 427	9 813	40 240	54 949	95 189	385 516	44 009	65 798	29 391	45	67
1985r	30 885	9 813	40 698	56 048	96 746	406 038	46 351	71 309	25 437	34	65
1986r	30 980	11 098	42 078	57 731	99 809	421 817	48 153	70 314	29 495	42	68
1987p	31 084	11 928	43 012	57 731	100 743	438 152	50 017	74 302	26 441	36	67

(a) 1920-55: Figures are approximate, computed using actual Statistics Canada data for stations generating energy for sale, to which have been added estimates for stations generating entirely for own use. 1920-55: Canadian Energy Prospects (Royal Commission on Canada's Economic Prospects) John Davis, 1957. 1956-81: Statistics Canada Publication, 57-202.

(b) Average Demand = Energy Consumption ÷ 8 760 (hrs/yr).

(c) Statistics Canada Publication 57-204.

(d) Reserve margin = $\frac{\text{(Installed capacity} - \text{Peak demand)}}{\text{Peak demand}}$

(e) Load Factor = Average demand ÷ Peak demand.

p Preliminary figures. r Revised figures.

Source: Statistics Canada.
Energy, Mines and Resources Canada.

Table A2. Installed and proposed generating capacity, 1987

	Hydro	Nuclear	Conventional Thermal	Total	% of Canadian Total
	(MW)				
Newfoundland	6 644	0	758	7 402	7.36
Prince Edward Island	0	0	122	122	.12
Nova Scotia	386	0	1 960	2 346	2.33
New Brunswick	903	680	1 907	3 490	3.47
Quebec	25 849	685	1 110	27 644	27.47
Ontario	7 764	10 563	13 796	32 123	31.92
Manitoba	3 641	0	496	4 137	4.11
Saskatchewan	830	0	2 118	2 948	2.93
Alberta	734	0	6 871	7 605	7.56
British Columbia	10 848	0	1 660	12 508	12.43
Yukon	82	0	41	123	.12
Northwest Territories	50	0	140	190	.19
Canada (Totals as of December 31, 1987)	57 731	11 928	30 979	100 638	100.00
Percentage of total	57.37	11.85	30.78	100.00	
Net additions during 1987	0	830	4	834	
Planned additions, 1988	8	0	137	145	

Source: Energy, Mines and Resources Canada.

Table A3. Conventional thermal capacity by principal fuel type* (MW)

	Steam					Gas Turbine			Internal Combustion			All Conventional Thermal				
	Coal	Oil	Gas	Other	Total	Oil	Gas	Total	Oil	Gas	Total	Coal	Oil	Gas	Other**	Total
Nfld.	0	505	0	0	505	170	0	170	83	0	83	0	758	0	0	758
P.E.I.	0	70	0	0	70	41	0	41	11	0	11	0	122	0	0	122
N.S.	954	800	0	0	1 754	205	0	205	1	0	1	954	1 006	0	0	1 960
N.B.	285	1 561	0	22	1 868	23	0	23	16	0	16	285	1 600	0	22	1 907
Que.	0	628	0	10	638	363	0	363	109	0	109	0	1 100	0	10	1 110
Ont.	9 511	2 200	1 362	90	13 163	469	155	624	4	6	10	9 511	2 673	1 523	90	13 797
Man.	419	0	4	23	446	24	0	24	26	0	26	419	50	4	23	496
Sask.	1 772	0	141	43	1 956	0	155	155	7	0	7	1 772	7	296	43	2 118
Alta.	4 479	65	1 648	107	6 299	0	524	524	15	33	48	4 479	80	2 205	107	6 871
B.C.	0	126	1 038	247	1 411	100	54	154	78	17	95	0	304	1 109	247	1 660
Yukon	0	0	0	0	0	0	0	0	41	0	41	0	41	0	0	41
N.W.T.	0	0	0	0	0	0	20	20	120	0	120	0	120	20	0	140
Canada	17 420	5 955	4 193	542	28 110	1 395	908	2 303	511	56	567	17 420	7 861	5 157	542	30 980

* *Preliminary figures as of December 31, 1987.*
** *Mainly wood wastes and black liquor.*
Numbers may not total due to rounding.

Source: Electrical Energy Branch, Energy, Mines and Resources Canada.

Table A4. Electrical energy production by principal fuel type, 1987

	Conventional Thermal*								% of Total	% Generated By
	Coal	Oil	Gas	Total	Nuclear	Hydro	Total	Generation	Utilities	Industry
	(GW.h)									
Newfoundland	0	2 317	0	2 317	0	37 773	40 090	8.32	99.03	.97
Prince Edward Island	108	56	0	164	0	0	164	.03	34.15	65.85
Nova Scotia	5 436	1 539	0	6 975	0	774	7 749	1.61	95.48	4.52
New Brunswick	1 452	3 710	0	5 162	5 112	2 219	12 493	2.59	95.27	4.73
Quebec	0	182	0	182	4 660	152 110	156 952	32.56	89.52	10.48
Ontario	32 291	47	1 524	33 862	63 116	34 604	131 582	27.29	97.23	2.77
Manitoba	577	7	7	591	0	19 311	19 902	4.13	99.74	.26
Saskatchewan	8 931	12	309	9 252	0	3 188	12 440	2.58	97.12	2.88
Alberta	30 514	130	4 676	35 320	0	1 450	36 770	7.63	90.87	9.13
British Columbia	961	470	579	2 010	0	61 057	63 067	13.08	81.54	18.46
Yukon	0	23	0	23	0	409	432	.09	100.00	.00
N.W.T.	0	173	0	173	0	294	467	.10	94.22	5.78
Canada	80 270	8 666	7 095	96 031	72 888	313 189	482 108	100.00	89.51	10.49

** The conventional thermal breakdown is estimated.*

Source: Statistics Canada.
Energy, Mines and Resources Canada.

Table A5. Provincial electricity imports and exports (GW.h)

Province	Year	Interprovincial Trade			International Trade*			Total Net Exports
		Exports	Imports	Net Exports	Exports	Imports	Net Exports	
Newfoundland	1987	30 393	-	30 393	-	-	-	30 393
	1986	30 695	-	30 695	-	-	-	30 695
	1985	31 837	-	31 837	-	-	-	31 837
	1984	36 043	-	36 043	-	-	-	36 043
	1983	31 234	-	31 234	-	-	-	31 234
Prince Edward Island	1987	-	483	-483	-	-	-	-483
	1986	-	610	-610	-	-	-	-610
	1985	-	575	-575	-	-	-	-575
	1984	-	539	-539	-	-	-	-539
	1983	-	519	-519	-	-	-	-519
Nova Scotia	1987	82	659	-577	-	-	-	-577
	1986	71	611	-540	-	-	-	-540
	1985	199	350	-151	-	-	-	-151
	1984	282	301	-19	-	-	-	-19
	1983	121	723	-602	-	-	-	-602
New Brunswick	1987	1 164	6 922	-5 758	6 141	266	5 875	117
	1986	1 230	7 275	-6 045	7 008	424	6 584	539
	1985	927	6 026	-5 099	6 093	12	6 081	982
	1984	841	4 588	-3 747	5 657	17	5 640	1 893
	1983	1 245	4 112	-2 867	5 265	24	5 241	2 374
Quebec	1987	12 782	30 427	-17 645	16 401	-	16 401	-1 244
	1986	14 496	30 712	-16 216	12 674	35	12 639	-3 577
	1985	14 491	31 878	-17 387	9 581	3	9 578	-7 809
	1984	11 668	36 105	-24 437	11 250	8	11 242	-13 195
	1983	9 371	31 290	-21 919	10 128	8	10 120	-11 799
Ontario	1987	16	6 992	-6 976	8 497	2 113	6 384	-592
	1986	22	8 027	-8 005	7 957	1 693	6 264	-1 441
	1985	44	9 632	-9 588	10 563	1 701	8 862	-726
	1984	64	8 302	-8 238	11 370	913	10 457	2 219
	1983	59	6 336	-6 277	12 207	369	11 838	5 561
Manitoba	1987	2 311	1 220	1 091	3 461	512	2 949	4 040
	1986	1 946	1 087	859	6 989	12	6 977	7 836
	1985	2 524	1 238	1 286	5 660	45	5 615	6 901
	1984	2 565	1 301	1 264	5 057	43	5 014	6 278
	1983	2 555	1 213	1 342	5 994	19	5 975	7 317

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Table A5. Provincial electricity imports and exports (GW.h) (Continued)

Province	Year	Interprovincial Trade			International Trade*			Total Net Exports
		Exports	Imports	Net Exports	Exports	Imports	Net Exports	
Saskatchewan	1987	1 222	1 262	-40	113	84	29	-11
	1986	1 076	1 210	-134	151	64	87	-47
	1985	1 236	1 556	-320	163	93	70	-250
	1984	1 302	1 625	-323	86	66	20	-303
	1983	1 210	1 601	-391	81	84	-3	-394
Alberta	1987	710	526	184	-	2	-2	182
	1986	617	555	62	-	3	-3	59
	1985	243	278	-35	-	2	-2	-37
	1984	262	302	-40	-	2	-2	-42
	1983	198	346	-148	-	2	-2	-150
British Columbia	1987	521	710	-189	12 815	493	12 322	12 133
	1986	553	617	-64	4 156	2 727	1 429	1 365
	1985	275	243	32	10 956	837	10 119	10 151
	1984	298	262	36	8 015	1 294	6 721	6 757
	1983	341	196	145	4 633	2 251	2 382	2 527
Yukon	1987	-	-	-	-	-	-	-
	1986	-	-	-	-	-	-	-
	1985	-	-	-	-	-	-	-
	1984	-	-	-	-	-	-	-
	1983	-	-	-	-	-	-	-
Northwest Territories	1987	-	-	-	-	-	-	-
	1986	-	-	-	-	-	-	-
	1985	-	-	-	-	-	-	-
	1984	-	-	-	-	-	-	-
	1983	-	-	-	-	-	-	-
Canada	1987	-	-	-	47 428	3 470	43 958	43 958
	1986	-	-	-	38 934	4 957	33 977	33 977
	1985	-	-	-	43 016	2 693	40 323	40 323
	1984	-	-	-	41 436	2 343	39 093	39 093
	1983	-	-	-	38 308	2 757	35 551	35 551

** Includes exchanges.*

Source: Statistics Canada.

Table A6. Electricity exports by utility, 1987

Exporter	Importer	Revenue ($000)	Quantity (GW.h)
Fraser Inc.	Maine	16 484	378
Maine & New Brunswick Electrical Power Co. Ltd.	Maine	1 354	72
N.B. Power	Maine	139 764	3 646
N.B. Power	Massachusetts	120 431	1 813
Hydro-Québec	Maine	47	1
Hydro-Québec	Vermont	70 648	1 914
Hydro-Québec	NEPOOL	136 241	4 773
Hydro-Québec	New York	238 410	9 712
St. Lawrence Power Co.	New York	6 742	282
Ontario Hydro	Vermont	10 401	264
Ontario Hydro	New York	158 079	5 420
Ontario Hydro	Michigan	22 459	807
Ontario Hydro	Minnesota	113	3
Canadian Niagara Power Co.	New York	14 774	418
Boise Cascade Canada Ltd.	Minnesota	5	N
Manitoba Hydro	Minnesota	51 083	2 561
Manitoba Hydro	North Dakota	14 342	753
SaskPower	North Dakota	168	55
Cominco Ltd.	Washington	2 370	152
Cominco Ltd.	Oregon	3 024	176
Cominco Ltd.	Idaho	67	4
Cominco Ltd.	Montana	339	24
Cominco Ltd.	California	8 886	484
Cominco Ltd.	Nevada	111	7
Cominco Ltd.	Utah	22	2

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Table A6. Electricity exports by utility, 1987 (Continued)

Exporter	Importer	Revenue ($000)	Quantity (GW.h)
West Kootenay Power	Washington	1	N
B.C. Hydro	Washington	27 924	1 530
B.C. Hydro	Oregon	62 638	4 481
B.C. Hydro	Idaho	614	37
B.C. Hydro	Montana	67	4
B.C. Hydro	California	99 631	5 537
B.C. Hydro	Nevada	166	12
B.C. Hydro	Utah	498	35
B.C. Hydro	Alaska	64	N

N = negligible

Source: Energy, Mines and Resources Canada.

Table A7. Generation capacity by type (MW)

	Steam	Gas Turbine	Internal Combustion	Nuclear	Total Thermal	Hydro	Total
NEWFOUNDLAND							
Total end 1986	504.60	170.39	82.81	.00	757.80	6 643.80	7 401.60
Additions 1987	-	-	-	-	.00	-	.00
Total end 1987	504.60	170.39	82.81	.00	757.80	6 643.80	7 401.60
Additions proposed							
1988	25.00	-	-	-	25.00	8.00	33.00
1989	25.00	-	-	-	25.00	-	25.00
1990	-	108.00	-	-	108.00	-	108.00
1991	-	-	-	-	.00	30.00	30.00
1992	-	54.00	-	-	54.00	-	54.00
2003	-	54.00	-	-	54.00	-	54.00
2004	-	54.00	-	-	54.00	-	54.00
Total end 2004	554.60	440.39	82.81	.00	1 077.80	6 681.80	7 759.60
PRINCE EDWARD ISLAND							
Total end 1986	70.50	40.85	11.14	.00	122.49	.00	122.49
Additions 1987	-	-	-	-	.00	-	.00
Total end 1987	70.50	40.85	11.14	.00	122.49	.00	122.49
NOVA SCOTIA							
Total end 1986	1 753.79	205.00	0.60	.00	1 959.39	386.36	2 345.75
Additions 1987	-	-	-	-	.00	-	.00
Total end 1987	1 753.79	205.00	0.60	.00	1 959.39	386.36	2 345.75
Additions proposed							
1991	150.00	-	-	-	150.00	-	150.00
1993	150.00	-	-	-	150.00	-	150.00
1994	300.00	-	-	-	300.00	-	300.00
1995	150.00	-	-	-	150.00	-	150.00
1998	300.00	-	-	-	300.00	-	300.00
2001	150.00	-	-	-	150.00	-	150.00
2003	300.00	-	-	-	300.00	-	300.00
Total end 2003	3 253.79	205.00	0.60	.00	3 459.39	386.36	3 845.75
NEW BRUNSWICK							
Total end 1986	1 868.08	23.38	16.34	680.00	2 587.80	903.03	3 490.83
Additions 1987	-	-	-	-	.00	-	.00
Total end 1987	1 868.08	23.38	16.34	680.00	2 587.80	903.03	3 490.83
Additions proposed							
1993	400.00	-	-	-	400.00	-	400.00
1995	200.00	-	-	-	200.00	-	200.00
1998	400.00	-	-	-	400.00	-	400.00
Total end 1998	2 868.08	23.38	16.34	680.00	3 587.80	903.03	4 490.83

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Table A7. Generation capacity by type (MW) (Continued)

	Steam	Gas Turbine	Internal Combustion	Nuclear	Total Thermal	Hydro	Total
QUEBEC							
Total end 1986	371.35	362.88	109.18	685.00	1 528.41	25 848.91	27 377.32
Additions 1987	-	-	-	-	.00	-	.00
Total end 1987	371.35	362.88	109.18	685.00	1 528.41	25 848.91	27 377.32
Additions proposed							
1989	-	-	-	-	.00	1 056.00	1 056.00
1990	-	-	-	-	.00	-	.00
1991	-	-	-	-	.00	-	.00
1992	-	-	-	-	.00	950.00	950.00
1993	-	-	-	-	.00	950.00	950.00
1994	-	-	-	-	.00	-	.00
1995	-	-	-	-	.00	1 431.00	1 431.00
1996	-	-	-	-	.00	1 033.00	1 033.00
1997	-	-	-	-	.00	500.00	500.00
1998	-	-	-	-	.00	822.00	822.00
1999	-	-	-	-	.00	1 187.00	1 187.00
2000	-	-	-	-	.00	791.00	791.00
2001	-	-	-	-	.00	913.00	913.00
2002	-	-	-	-	.00	219.00	219.00
2003	-	-	-	-	.00	601.00	601.00
2004	-	-	-	-	.00	775.00	775.00
2005	-	372.00	-	-	372.00	249.00	621.00
2006	-	-	-	-	.00	621.00	621.00
Total end 2006	371.35	734.88	109.18	685.00	1 900.41	37 946.91	37 850.32
ONTARIO							
Total end 1986	13 162.49	623.57	9.52	9 733.00	23 528.58	7 763.60	31 292.18
Additions 1987	-	-	-	830.00	830.00	-	830.00
Total end 1987	13 162.49	623.57	9.52	10 563.00	24 358.58	7 763.60	32 122.18
Additions proposed							
1988	-	104.00	-	-	104.00	-	104.00
1989	-	-	-	1 762.00	1 762.00	43.00	1 805.00
1990	-	-	-	-	.00	-	.00
1991	-	-	-	881.00	881.00	-	881.00
1992	-	-	-	881.00	881.00	-	881.00
Total end 1992	13 162.49	727.57	9.52	14 087.00	27 986.58	7 806.60	35 793.18

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Table A7. Generation capacity by type (MW) (Continued)

	Steam	Gas Turbine	Internal Combustion	Nuclear	Total Thermal	Hydro	Total
MANITOBA							
Total end 1986	445.80	23.80	26.44	-	496.04	3 641.10	4 137.14
Additions 1987	-	-	-	-	.00	-	.00
Total end 1987	445.80	23.80	26.44	.00	496.04	3 641.10	4 137.14
Additions proposed							
1990	-	-	-	-	.00	256.00	256.00
1991	-	-	-	-	.00	640.00	640.00
1992	-	-	-	-	.00	384.00	384.00
1999	-	-	-	-	.00	260.00	260.00
2000	-	-	-	-	.00	390.00	390.00
2001	-	-	-	-	.00	650.00	650.00
2012	-	-	-	-	.00	87.50	87.50
2013	-	-	-	-	.00	262.50	262.50
Total end 2013	445.80	23.80	26.44	.00	496.04	6 571.10	7 067.14
SASKATCHEWAN							
Total end 1986	1 956.76	154.92	6.60	.00	2 118.28	830.00	2 948.28
Additions 1987	-	-	-	-	.00	-	.00
Total end 1987	1 956.76	154.92	6.60	.00	2 118.28	830.00	2 948.28
Additions proposed							
1990	-	100.00	-	-	100.00	-	100.00
1991	-	50.00	-	-	50.00	-	50.00
1992	-	50.00	-	-	50.00	-	50.00
Total end 1992	1 956.76	354.92	6.60	.00	2 318.28	830.00	3 148.28
ALBERTA							
Total end 1986	6 298.22	524.10	48.28	.00	6 870.60	733.70	7 604.30
Additions 1987	-	-	-	-	.00	-	.00
Total end 1987	6 298.22	524.10	48.28	.00	6 870.60	733.70	7 604.30
Additions proposed							
1989	400.00	-	-	-	400.00	-	400.00
1991	400.00	-	-	-	400.00	-	400 00
1994	-	200.00	-	-	200.00	-	200.00
1995	375.00	-	-	-	375.00	-	375.00
1996	375.00	100.00	-	-	475.00	-	475.00
1997	375.00	-	-	-	375.00	-	375.00
1998	-	400.00	-	-	400.00	-	400.00
1999	375.00	100.00	-	-	475.00	-	475.00
2000	375.00	300.00	-	-	675.00	-	675.00
2001	375.00	-	-	-	375.00	-	375.00
2003	750.00	100.00	-	-	850.00	-	850.00
2004	375.00	-	-	-	375.00	-	375.00
Total end 2004	10 473.22	1 724.10	48.28	.00	12 245.60	733.70	12 979.30

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Table A7. Generation capacity by type (MW) (Continued)

	Steam	Gas Turbine	Internal Combustion	Nuclear	Total Thermal	Hydro	Total
BRITISH COLUMBIA							
Total end 1986	1 411.42	153.70	92.25	.00	1 660.37	10 847.87	12 508.24
Additions 1987	-	-	-	-	.00	-	.00
Total end 1987	1 411.42	153.70	92.25	.00	1 660.37	10 847.87	12 508.24
Additions proposed							
2000	-	-	-	-	.00	300.00	300.00
2001	-	-	-	-	.00	760.00	760.00
2002	-	-	-	-	.00	80.00	80.00
2003	-	-	-	-	.00	-	.00
2004	-	-	-	-	.00	110.00	110.00
2005	500.00	-	-	-	500.00	110.00	610.00
2006	500.00	-	-	-	500.00	55.00	555.00
2007	500.00	-	-	-	500.00	-	500.00
2008	500.00	-	-	-	500.00	-	500.00
Total end 2008	3 411.42	153.70	95.25	.00	3 660.37	12 262.87	15 923.24
YUKON and N.W.T.							
Total end 1986	.00	19.50	161.41	.00	180.91	131.70	312.61
Additions 1987	-	-	4.10	-	4.10	-	4.10
Total end 1987	.00	19.50	165.51	.00	185.01	131.70	316.71
Additions proposed							
1988	-	-	8.20	-	8.20	-	8.20
1989	-	-	1.60	-	1.60	-	1.60
1990	-	-	1.70	-	1.70	-	1.70
1991	-	-	1.70	-	1.70	-	1.70
1992	-	-	2.40	-	2.40	-	2.40
1993	-	-	1.20	-	1.20	-	1.20
1994	-	-	.50	-	.50	-	.50
Total end 1994	.00	19.50	182.81	.00	202.31	131.70	334.01

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Table A7. Generation capacity by type (MW) (Continued)

	Steam	Gas Turbine	Internal Combustion	Nuclear	Total Thermal	Hydro	Total
CANADA							
Total end 1986	27 843.01	2 302.09	567.57	11 098.00	41 810.67	57 730.07	100 298.54
Additions 1987	-	-	4.10	830.00	834.10	-	834.10
Total end 1987	27 843.01	2 302.09	571.67	11 928.00	42 644.77	57 730.07	101 132.64
Additions proposed							
1988	25.00	104.00	8.20	-	137.20	8.00	145.20
1989	425.00	-	1.60	1 762.00	2 188.60	1 099.00	3 287.60
1990	-	208.00	1.70	-	209.70	256.00	465.70
1991	550.00	50.00	1.70	881.00	1 482.70	670.00	2 152.70
1992	-	104.00	2.40	881.00	987.40	1 334.00	2 321.40
1993	550.00	-	1.20	-	551.20	950.00	1 501.20
1994	300.00	200.00	.50	-	500.50	-	500.50
1995	725.00	-	-	-	725.00	1 431.00	2 156.00
1996	375.00	100.00	-	-	475.00	1 033.00	1 508.00
1997	375.00	-	-	-	375.00	500.00	875.00
1998	700.00	400.00	-	-	1 100.00	822.00	1 922.00
1999	375.00	100.00	-	-	475.00	1 447.00	1 922.00
2000	375.00	300.00	-	-	675.00	1 481.00	2 156.00
2001	525.00	-	-	-	525.00	2 323.00	2 848.00
2002	-	-	-	-	.00	299.00	299.00
2003	1 050.00	154.00	-	-	1 204.00	601.00	1 805.00
2004	375.00	54.00	-	-	429.00	885.00	1 314.00
2005	500.00	372.00	-	-	872.00	359.00	1 231.00
2006	500.00	-	-	-	500.00	676.00	1 176.00
2007	500.00	-	-	-	500.00	-	500.00
2008	500.00	-	-	-	500.00	-	500.00
2012	-	-	-	-	.00	87.50	87.50
2013	-	-	-	-	.00	262.50	262.50
Total end 2013	36 568.01	4 448.09	588.97	15 452.00	57 057.07	74 254.07	131 311.14

Source: Energy, Mines and Resources Canada.

Table A8. Installed generating capacity expansion in Canada by station. Major 1987 additions and 1988 - 2013 projections

Province and Station	Type*	1987 Additions	Completion Date	Additions Proposed	Status*	Plant Capacity
		(MW)		(MW)		(MW)
NEWFOUNDLAND						
Holyrood[1]	S(o)		1988	25	P	
			1989	25	P	500
Paradise River	H		1988	8	C	8
Stephenville	GT(o)		1990	54	P	108
Hardwoods	GT(o)		1990	54	P	108
Island Pond	H		1991	30	C	30
Undecided	GT(o)		1992	54	P	
			2003	54	P	
			2004	54	P	
NOVA SCOTIA						
New Coal "A"	S(c)		1993	150	C	
			1995	150	P	
			2001	150	P	450
New Coal "B"	S(c)		1994	300	P	
			1998	300	P	
			2003	300	P	900
Trenton	S(c)		1991	150	C	360
NEW BRUNSWICK						
New Steam	S(c)		1993	400	P	
			1998	400	P	800
Grand Lake	S(c)		1995	200	P	285

[1] Uprating of exising units.

.../2

Table A8. Installed generating capacity expansion in Canada by station. Major 1987 additions and 1988 - 2013 projections (Continued)

Province and Station	Type*	1987 Additions	Completion Date	Additions Proposed	Status*	Plant Capacity
		(MW)		(MW)		(MW)
QUEBEC						
La Forge-1	H		1995	5 × 130	P	
			1995	133	P	783
La Forge-2	H		2003	3 × 90	P	270
Manic-3A	H		1997	2 × 250	P	500
Manic-5A	H		1989	4 × 264	C	1 056
Brisay	H		1996	193	P	
			1996	192	P	385
LG-1	H		1995	6 × 108	P	
			1996	6 × 108	P	1 296
LG-2A	H		1992	2 × 317	P	
			1992	316	P	
			1993	2 × 317	P	
			1993	316	P	1 900
Ste-Marguerite	H		1998	2 × 411	P	822
Grande Baleine-1	H		1999	2 × 396	P	
			1999	395	P	
			2000	396	P	
			2000	395	P	1 978
Grande Baleine-2	H		2001	154	P	
			2001	2 × 153	P	460
Grande Baleine-3	H		2001	3 × 151	P	453
Ashuapmushuan-3	H		2003	111	P	
			2003	2 × 110	P	331
Ashuapmushuan-4	H		2002	109	P	
			2002	110	P	219
Eastmain-1	H		2004	3 × 170	P	510
Quenonisca	H		2004	5 × 53	P	265
Broadback-8	H		2005	124	P	
			2005	125	P	
			2006	4 × 124	P	
			2006	125	P	870
Future peaking	GT(d)		2005	372	P	372
ONTARIO						
Bruce B	N	830			I	3 320
Darlington	N		1989	2 × 881	C	
			1991	881	C	
			1992	881	C	
	GT		1988	4 × 26	C	3 628
Magpie	H		1989	4 × 7.5	P	
			1989	2 × 6.5	P	43

Table A8. Installed generating capacity expansion in Canada by station. Major 1987 additions and 1988 - 2013 projections (Continued)

Province and Station	Type*	1987 Additions	Completion Date	Additions Proposed	Status*	Plant Capacity
		(MW)		(MW)		(MW)
MANITOBA						
Limestone	H		1990	2 × 128	C	
			1991	5 × 128	C	
			1992	3 × 128	C	1 280
Conawapa	H		1999	2 × 130	P	
			2000	3 × 130	P	
			2001	5 × 130	P	1 300
Wuskwatim	H		2012	87.5	P	
			2013	3 × 87.5	P	350
SASKATCHEWAN						
Shand	S(c)		1992	300	C	300
Future peaking 1	GT(g)		1990	50	P	50
Future peaking 2	GT(g)		1990	50	P	50
Future peaking 3	GT(g)		1991	50	P	50
ALBERTA						
Genesee	S(c)		1989	400	C	
			1991	400	C	800
Sheerness	S(c)		1990	380	C	760
New Steam	S(c)		1995	375	P	
			1996	375	P	
			1997	375	P	
			1999	375	P	
			2000	375	P	
			2001	375	P	
			2003	2 × 375	P	
			2004	375	P	3 375
Peak Gas	GT		1994	2 × 100	P	
			1996	100	P	
			1998	4 × 100	P	
			1999	100	P	
			2000	3 × 100	P	
			2003	100	P	1 200

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Table A8. Installed generating capacity expansion in Canada by station. Major 1987 additions and 1988 - 2013 projections (Continued)

Province and Station	Type*	1987 Additions	Completion Date	Additions Proposed	Status*	Plant Capacity
		(MW)		(MW)		(MW)
BRITISH COLUMBIA						
Keenleyside	H		2001	2 × 80	P	
			2002	80	P	240
Peace Site C	H		2000	2 × 150	P	
			2001	4 × 150	P	900
Murphy Creek	H		2004	2 × 55	P	
	H		2005	2 × 55	P	
			2006	55	P	275
Hat Creek	S(c)		2005	500	P	
			2006	500	P	
			2007	500	P	
			2008	500	P	2 000
YUKON						
Dawson	IC	1				3.4
NORTHWEST TERRITORIES						
Various	IC	3.1				
			1988	8.2	P	
			1989	1.6	P	
			1990	1.7	P	
			1991	1.7	P	
			1992	2.4	P	
			1993	1.2	P	
			1994	0.5	P	

* **Legend**

H	*Hydro*	*IC*	*Internal combustion*
S(c)	*Steam (coal)*	*GT*	*Gas turbine*
S(o)	*Steam (oil)*	*I*	*Installed*
N	*Nuclear*	*C*	*Under construction*
P	*Planned*		
GT(o)	*Gas turbine (oil)*		
GT(G)	*Gas turbine (natural gas)*		

Source: Energy, Mines and Resources Canada.

APPENDIX B

B1. Chronology of Canadian Electrical Energy Developments and Achievements 105

B2. Chronology of Regional Interconnections 107

B1. Chronology of Canadian Electrical Energy Developments and Achievements

1846	Toronto, Hamilton, Niagara, and St. Catharines Electro-Magnetic Telegraph Company formed.
1847	Montreal Telegraph Company formed with lines from Quebec City to Toronto.
1858	Message sent from Queen Victoria to U.S. President Buchanan via first trans-Atlantic cable from Valentia, Ireland, to White Sands Bay, Newfoundland.
1873	Davis House in Winnipeg used arc light to illuminate front of building.
1876	Alexander Graham Bell made first long-distance telephone call from Paris, Ontario, to Brantford, Ontario, via battery power in Toronto — a total distance of 218 km.
1878	Robert McMicking began experiments with electric street lighting in Victoria.
1878	American Electric and Illuminating Company formed in Montreal – Canada's first electric light company.
1879	British Columbia Electric Railway launched.
1879	Electric light demonstrated in McConkey's Restaurant, Toronto.
1881	Toronto's first electric generator built by J.J. White. T. Eaton was the first customer.
1881	Ahearn & Soper of Ottawa introduced electric light for industry.
1882	One of North America's first hydroelectric generating facilities constructed at Chaudière Falls on the Ottawa River.
1882	F. Nicholls formed Toronto Electric Supply Company (forerunner of Canadian General Electric).
1883	Canada's first electric lighting plant started at Canadian Cottons, Cornwall, Ontario, by Thomas Edison.
1883	Toronto's first electric railway built by J.J. Wright.
1883	Canada's first street lights installed in Hamilton, Ontario.
1884	Canada's first electric utility set up in Pembroke, Ontario, by R.B. McAllister.
1884	Electric street lighting installed in Montreal and Toronto.
1885	First Canadian electric streetcar enters service in Toronto.
1885	St. John's Electric Light Company produced power for street and shop lighting.
1886	Victoria Electric Lighting Company (forerunner of B.C. Electric and B.C. Hydro) formed.
1887	Hydroelectric plant built at Twelve Mile Creek, near Welland, Ontario.
1889	Calgary sawmill run by electricity; electric lights in Calgary, Brandon, and Winnipeg.
1890	Electric lights in Regina, Kenora, Portage la Prairie, and Moosejaw.
1891	Canadian Electrical Association formed.
1892	Canadian General Electric incorporated.
1892	Montreal's first hydroelectric plant established on the Lachine Canal.
1892	Canadian Niagara Power Company incorporated.
1892	Thomas L. "Carbide" Willson of Woodstock, Ontario, developed the electric-furnace process to manufacture calcium carbide.
1896	Marconi applied for a patent on wireless telegraphy.
1897	Hydroelectric power from Montmorency Falls supplies street lighting in Quebec City.
1897	Canadian branch of Westinghouse established at Hamilton.
1897	First long-distance, high-voltage transmission line (11 kV) carried power from St. Narcisse, to Trois-Rivières, Quebec — a distance of 29 km.
1898	Shawinigan Water & Power Company incorporated in Quebec.
1898	Royal Electric generated 15 MW at Chambly for transmission 26 km to Montreal.
1900	Hydroelectric power distributed in all provinces except Prince Edward Island and Saskatchewan.
1900	Montreal Light, Heat and Power Company formed.
1900	Canada's installed hydroelectric capacity reached 133 MW.
1901	Trans-Atlantic wireless demonstrated from Newfoundland by Marconi.
1902	Shawinigan aluminium plant produced conductors for the Shawinigan-Montreal transmission line.
1902	A communications cable between Canada and Australia — the Pacific Cable — was successfully completed. The Pacific Cable was developed by Canadian engineer Sir Sandford Fleming.
1903	Shawinigan Water & Power installed the world's largest generator (5,000 hp) and transmitted power over the world's longest and highest voltage line — 136 km to Montreal at 50 kV.
1904	First significant exchange of power with the United States initiated at Niagara Falls.

1905	Ontario Hydro established.
1906	Hydroelectric power transmitted 96 km from the Winnipeg River to Winnipeg.
1910	Canada's installed hydroelectric capacity reached 700 MW.
1910	First 110-kV transmission line built from Niagara Falls to Dundas, Ontario.
1910	Quebec Streams Commission established.
1918	New Brunswick Electric Power Commission created.
1918	Maritime Electric Company established.
1919	Ernest Rutherford of McGill University achieved atomic fission.
1919	Manitoba Power Commission established.
1919	Nova Scotia Power Commission established.
1921	Sir Adam Beck No.1 generating plant opened in Niagara Falls, then the largest in the world. Total capacity installed by 1924 was 528 MW.
1924	Newfoundland Light & Power Company established.
1929	Saskatchewan Power Corporation formed.
1930	Canada's installed generating capacity reached 4700 MW.
1944	Hydro-Québec formed; acquired the facilities of the Montreal Light, Heat and Power Company.
1948	The Northwest Territories Power Commission was created. In 1956, it was renamed the Northern Canada Power Commission.
1951	First 100-MW thermal generating unit installed.
1954	Newfoundland and Labrador Hydro created.
1956	First 315-kV transmission lines energized to carry power from Bersimis No.1 in northeastern Quebec to Quebec City and Montreal.
1957	First Canadian pumping/generating station (capacity 177 MW) enters service at Niagara Falls.
1958	Great Lakes Power Company installed highest head (34 m) variable pitch blade Kaplan turbine in North America.
1960	Beauharnois (Quebec) first generating station to exceed 1000 MW installed. By 1986, installed capacity at this station reached 1639 MW.
1961	First 300-MW thermal generating unit installed at Lakeview, Ontario.
1962	Saskatchewan Power installed first 25-kV underground residential distribution system.
1962	B.C. Hydro acquired the B.C. Electric Company.
1963	Hydro-Québec acquired private power companies, including Shawinigan Water & Power.
1965	First 735-kV transmission line from Manicouagan-Outardes to the Quebec load centres energized. At the time, it was the highest A.C. voltage in commercial use in the world.
1967	First commercial-scale (220 MW) CANDU nuclear generating station in service at Douglas Point, Ontario.
1967	Ontario Hydro completes a 696-km, 500-kV transmission line from James Bay generating stations to Toronto.
1968	Power from Peace River transmitted to the B.C. lower mainland via a 918-km, 500-kV line.
1968	First Canadian D.C. transmission line in service between Vancouver Island and the mainland at 260 kV.
1969	First 500-MW thermal generating unit operating at Lambton, Ontario.
1971	First two of four 542-MW nuclear generating units commissioned at Pickering, Ontario.
1971	First two units (500 MW and 475 MW) of the Churchill Falls, Labrador, hydroelectric station commissioned.
1972	World's largest solid-state high-voltage, direct-current (HVDC) converter/inverter terminal (320 MW) placed in service at Eel River, New Brunswick.
1972	An 880-km, 450-kV HVDC long-distance transmission system placed in commercial operation from the Nelson River to Winnipeg.
1973	Nova Scotia Power Commission became Nova Scotia Power Corporation, incorporating Nova Scotia Light & Power Company.
1974	Completion of the Churchill Falls generating station, with a total capacity of 5429 MW.
1976	First 825-MW unit of the Bruce nuclear generating complex commissioned. (Total capacity of the complex is now 6600 MW.)
1978	New Brunswick-P.E.I. 100-MW submarine cable interconnection placed in service.
1979	First four 333-MW units of the LG 2 (James Bay) hydroelectric station placed in service by Hydro-Québec. (Total station capacity is 5328 MW, achieved by 1981.)
1983	Point Lepreau No.1 nuclear power unit (680 MW) placed in service by N.B. Power at Point Lepreau, New Brunswick.
1984	First tidal power generating plant in North America placed in service by Nova Scotia Power at Annapolis Royal, Nova Scotia.

B2. Chronology of Regional Interconnections

Interconnection	Voltage (kV)	Date-in-Service
Quebec-Ontario	230	1928
Quebec-Ontario	115	1930 (1)
Quebec-Ontario	230	1932
Quebec-Ontario	115	1933 (1)
Quebec-Ontario	115	1940 (1)
Quebec-Ontario	230	1941
Quebec-Ontario	115	1942
Quebec-Ontario	115	1949
Quebec-Ontario	115	1949
Manitoba-Ontario	115	1956 (2)
Manitoba-Saskatchewan	230	1960
New Brunswick-Nova Scotia	138	1961
New Brunswick-Nova Scotia	138	1965
Quebec-New Brunswick	69	1965
Quebec-Ontario	115	1966
Quebec-Ontario	115	1966
Western Ontario-Eastern Ontario	230	1969
Labrador-Quebec	735	1971
Labrador-Quebec	735	1972
Western Ontario-Eastern Ontario	230	1972
Manitoba-Saskatchewan	230	1972
Manitoba-Ontario	230	1972
Quebec-New Brunswick	±80 (DC)	1972
Quebec-New Brunswick	230	1972
Manitoba-Ontario	230	1973
Labrador-Quebec	735	1973
Alberta-British Columbia	138	1973
New Brunswick-Nova Scotia	345	1976 (3)
New Brunswick-Prince Edward Island	138	1977 (4)
New Brunswick-Prince Edward Island	138	1977 (4)
Manitoba-Saskatchewan	230	1979
Alberta-British Columbia	500	1985
Quebec-New Brunswick	±80 (DC)	1985
Quebec-New Brunswick	345	1985

Notes: (1) 230-kV construction.
(2) Constructed in 1931; interconnected in 1956.
(3) Operated at 138 kV until 1979.
(4) Submarine cable.

All interconnections are alternating current (AC), except for the Quebec-New Brunswick direct current (DC) facilities.

All Quebec-Ontario interconnections and both Quebec-New Brunswick AC interconnections are radial (i.e. between one system and an isolated section of the other system).

APPENDIX C

C1. Remaining Hydroelectric Potential in Canada*

Sites	Gross Potential (MW)	Identified Potential (MW)	Planning Potential (MW)	Capacity** Factor (%)
NEWFOUNDLAND				
Gull Island	1 698	1 698	1 698	76
Muskrat Falls	618	618	618	87
Lobstick	160	160	160	71
Pinware	77	77	77	67
Alexis	98	98	98	72
Paradise (Lab.)	89	89	89	66
Minipi	255	255	255	76
Fig	204	204	204	77
Eagle River	661	661	661	71
Naskaupi	290	290	290	73
Kaniriktok	394	394	394	75
Granite Canal	31	31	31	80
Island Pond	30	30	30	70
Round Pond	18	18	18	84
Sub total	4 623	4 623	4 623	
OTHER SITES				
> 10 MW	186	-	-	61
< 10 MW	392	-	-	61
TOTAL ALL SITES	5 201	4 623	4 623	
NOVA SCOTIA				
> 10 MW	75	75	-	61
< 10 MW	15	15	-	61
Sub total	90	90	-	
TIDAL				
Cumberland Basin	1 428	1 428	-	26
Minas Basin	5 338	5 338	-	30
Shepody Bay	1 643	1 643	-	25
TOTAL ALL SITES	8 499	8 499	0	
NEW BRUNSWICK				
Grand Falls (Ext)	300	300	300	21
Morrill	140	140	140	35
OTHER SITES	340	-	-	61
TOTAL ALL SITES	780	440	440	

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Remaining Hydroelectric Potential in Canada* (Continued)

Sites	Gross Potential (MW)	Identified Potential (MW)	Planning Potential (MW)	Capacity** Factor (%)
QUEBEC				
LG-1	1 296	1 296	1 296	64
Laforge-1	783	783	783	61
Brisay	385	385	385	68
Eastmain-1	522	522	522	63
Eastmain-2	200	200	-	74
Ste-Marguerite	822	822	822	58
Grande Baleine	2 891	2 891	2 891	60
Ashuapmushuan	533	533	533	77
NBR	8 700	8 700	8 700	61
Nastapoca	768	768	-	59
Sakami	187	187	-	79
La Romaine	1 710	1 710	1 710	59
Laforge-2	270	270	270	72
Haut St-Maurice	499	499	-	64
Matawin	212	212	-	75
Outaouais Sup.	281	281	-	45
Rapide-Manigance	78	78	-	88
Temiscamingue	195	195	-	53
Toulnoustouc	71	71	-	48
Aguanus	329	329	-	79
Magpie	354	354	-	79
Moisie	1 014	1 014	-	79
Musquaro	86	86	-	78
Natashquan	703	703	-	79
Olomane	300	300	-	80
Petit-Mecatina	1 754	1 754	-	59
St-Augustin	66	66	-	59
St-Paul	157	157	-	53
A-la-Baleine	807	807	-	78
Arnaud-Payne	592	592	-	67
Aux-Feuilles	711	711	-	80
Caniapiscau	2 240	2 240	-	81
Eau-Claire	321	321	-	60
George	2 826	2 826	-	80
Harricana	1 032	1 032	-	80
Archipel	418	418	-	93
Other Ident. Sites	5 200	5 200	-	61
OTHER SITES	4 800	-	-	61
Sub total	44 113	39 313	17 912	
TIDAL	26 416	-	-	25
TOTAL ALL SITES	70 529	39 313	17 912	

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Remaining Hydroelectric Potential in Canada* (Continued)

Sites	Gross Potential (MW)	Identified Potential (MW)	Planning Potential (MW)	Capacity** Factor (%)
ONTARIO				
Long Sault Rapids	52	52	52	52
Abitibi Canyon (Ext)	464	464	464	3
Newpost Creek	26	26	-	77
Otter Rapids (Ext)	174	174	174	3
Nine Mile Rapids	295	295	295	28
Sand Rapids	131	131	-	31
Allan Rapids	131	131	-	31
Ear Falls (Ext)	15	15	15	37
Maynard Falls	47	47	47	57
Little Jackfish	132	132	132	49
Highland Falls	94	94	-	18
Farm Rapids	13	13	-	52
Steephill Falls	15	15	-	50
Magpie Falls	13	13	-	50
Mission Falls	15	15	-	51
Yellow Falls	54	54	-	26
Cypress Falls	42	42	-	29
Little Long (Ext)	61	61	61	13
Smoky Falls (Redev)	182	182	182	30
Harmon	68	68	68	16
Kipling	68	68	68	16
Grand Rapids	174	174	174	41
Thunderhouse Falls	42	42	-	48
Long Rapids	126	126	-	44
Mileage 66	81	81	-	40
Mileage 25	80	80	-	40
Patten Post	250	250	250	17
Ragged Chute (Redev)	89	89	89	20
Grey Goose	140	140	140	48
Renison	135	135	135	47
Adam Beck	565	565	565	35
Paquette Rapids	29	29	-	89
Mileage 74	58	58	-	17
Mileage 9	65	65	-	18
Spanish Site 4	80	80	-	38
Spanish Site 1	40	40	-	38
Denison Falls	36	36	-	29
Chicagouse Falls	28	28	-	38
Turnbull	20	20	-	38
Umbata Falls	51	51	-	40
Chigamiwingum	57	57	-	41
Sub total	4 238	4 238	2 911	
OTHER SITES				
> 10 MW	6 784	-	-	43
< 10 MW	1 365	-	-	67
TOTAL ALL SITES	12 387	4 238	2 911	

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Remaining Hydroelectric Potential in Canada* (Continued)

Sites	Gross Potential (MW)	Identified Potential (MW)	Planning Potential (MW)	Capacity** Factor (%)
MANITOBA				
Conawapa	1 240	1 240	1 240	64
Gillam Island	1 000	1 000	1 000	65
Gull	550	550	550	62
Birthday	550	550	550	68
Red Rock	220	220	220	67
Whitemud	280	280	280	61
Granville Falls	150	150	150	61
First Rapids	190	190	190	84
Manasan	260	260	260	70
Wuskwatim	330	330	330	69
Notigi	100	100	100	68
Kelsey (Ext)	220	220	220	26
Sub total	5 090	5 090	5 090	
OTHER SITES				
> 10 MW	3 000	-	-	61
< 10 MW	100	-	-	61
TOTAL ALL SITES	8 190	5 090	5 090	
SASKATCHEWAN				
Island Falls (Ext)	100	100	100	25
Wintego	285	285	285	68
Choiceland	150	150	150	48
Forks	400	400	400	51
Sub total	935	935	935	
OTHER SITES	1 254	-	-	61
TOTAL ALL SITES	2 189	935	935	

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Remaining Hydroelectric Potential in Canada* (Continued)

Sites	Gross Potential (MW)	Identified Potential (MW)	Planning Potential (MW)	Capacity** Factor (%)
ALBERTA				
Berland	71	71	-	61
McLeod	36	36	-	61
McLeod Valley	22	22	-	61
Pembina	12	12	-	61
Cardinal	3	3	-	61
Elk	25	25	-	61
Frontal	19	19	-	61
Isaak	18	18	-	61
Job	4	4	-	61
Olympus	11	11	-	61
Race	8	8	-	61
Southesk Diversion	21	21	-	61
Strike	27	27	-	61
Thistle	25	25	-	61
Thunder	19	19	-	61
Horseguard	1	1	-	61
Brazeau Forks	88	88	-	61
Carvel	135	135	-	61
Chambers Creek	47	47	-	61
Drayton Valley	162	162	-	61
Gap	91	91	-	61
Hairy Hill	182	182	-	61
Phoenix	80	80	-	61
Ramparts	122	122	-	61
Rocky Mountain	49	49	-	61
Shunda	48	48	-	61
Whirlpool	10	10	-	61
Magnolia	7	7	-	61
Vermillion	12	12	-	61
Carcajou	1 329	1 329	-	61
Dunvegan	256	256	256	61
Mile 232	898	898	-	61
Mile 251	1 011	1 011	-	61
Vermillion Chutes	75	75	-	61
18th Baseline	210	210	-	61
19th Baseline	337	337	-	61
Bolton	124	124	-	61
Cutbank	174	174	-	61
Kakwa	346	346	-	61
Meander	292	292	-	61
Peace River	253	253	-	61
Sulphur	84	84	-	61
Wapiti	228	228	-	61
Watino	346	346	-	61
West Watino	318	318	-	61
Dickson	7	7	-	61
Raven Dam Site	7	7	-	61
Alternative 4	1 667	1 667	1 667	61

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Remaining Hydroelectric Potential in Canada* (Continued)

Sites	Gross Potential (MW)	Identified Potential (MW)	Planning Potential (MW)	Capacity** Factor (%)
Bassano	1	1	-	61
Cochrane	19	19	-	61
Dalemead	112	112	-	61
Eyremore	17	17	-	61
Glenbow	29	29	-	61
Lac des Arcs	15	15	-	61
Radnor	21	21	-	61
Russell	41	41	-	61
Shepard	78	78	-	61
Castle Site (1978)	7	7	-	61
Brocket	14	14	-	61
Fort MacLeod	7	7	-	61
Three Rivers	25	25	-	61
Meridan	45	45	-	61
Rapid Narrows	14	14	-	61
Sub total	9 762	9 762	1 923	
OTHER SITES	9 051	-	-	61
TOTAL ALL SITES	18 813	9 762	1 923	

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Remaining Hydroelectric Potential in Canada* (Continued)

Sites	Gross Potential (MW)	Identified Potential (MW)	Planning Potential (MW)	Capacity** Factor (%)
BRITISH COLUMBIA				
Peace Site C	900	900	900	61
Keenleyside	180	180	180	54
Murphy Creek	275	275	275	74
Stikine-Iskut	2 900	2 900	2 900	61
Liard River	3 190	3 190	3 190	66
Falls River	22	22	22	47
Seven Mile Unit 4	200	200	200	16
Homathko	900	900	710	55
Elaho	340	340	340	70
Border	250	250	250	74
McGregor	360	360	360	61
Kemano Completion	520	520	520	61
Waneta (Ext)	190	190	190	30
Brilliant (Ext)	120	120	120	50
Shuswap	55	55	55	80
Beatrice Lake	31	31	31	68
Goat River	12	12	12	26
Peace Site E	600	600	-	61
Skeena	1 080	1 080	-	61
Yukon-Taku	3 700	3 700	-	61
Thorsen Creek	3	3	-	61
OTHER SITES	14 969	-	-	61
Sub total	30 797	15 828	10 255	
TIDAL				
Observation Inlet	662	662	-	25
Sechelt Inlet	54	54	-	25
TOTAL ALL SITES	31 513	16 544	10 255	

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Remaining Hydroelectric Potential in Canada* (Continued)

Sites	Gross Potential (MW)	Identified Potential (MW)	Planning Potential (MW)	Capacity** Factor (%)
YUKON				
Mid Yukon	560	560	560	68
Cassiar Bar	350	350	350	68
Wolverine	476	476	476	68
Detour	100	100	100	68
Granite	414	414	414	68
High Fraser Falls	300	300	300	68
Porcupine/Steward	110	110	83	68
False Canyon/Francis River	58	58	58	68
Lower Canyon	75	75	75	68
Liard Canyon	90	90	90	68
Aberdeen Falls/Pee	300	300	300	68
Bell/Porcupine River	110	110	110	68
Slate Rapids	42	42	42	68
Hoole Canyon	40	40	40	68
Hoole River	15	15	15	68
Ross River	30	30	30	68
Primrose/Kusawa	30	30	30	68
Little Salmon	15	15	15	68
Yukon-Taku	2 500	2 500	-	68
Yukon-Yaiga	3 000	3 000	-	68
Pelly River	630	630	-	68
Steward River	973	973	-	68
Frances River	150	150	-	68
Tashenshini River	160	160	-	68
Bates River	110	110	-	68
Peel River	300	300	-	68
Sub total	10 938	10 938	3 088	
OTHER SITES	761	-	-	68
TOTAL ALL SITES	11 699	10 938	3 088	

Remaining Hydroelectric Potential in Canada* (Continued)

Sites	Gross Potential (MW)	Identified Potential (MW)	Planning Potential (MW)	Capacity** Factor (%)
N.W.T.				
Anderson	160	160	-	60
Back	2073	2073	1162	60
Burnside	525	525	-	60
Camsell	29	29	-	60
Coppermine	279	279	149	60
Dubawnt River	178	178	-	60
Ferguson	16	16	-	60
Great Bear 1	438	438	204	60
Great Bear 2	414	414	-	60
Hornaday	91	91	-	60
Horton	115	115	-	60
Hayes	120	120	-	60
Hood	52	52	-	60
Kakisa	21	21	13	60
Kasan	64	64	-	60
Maguse	39	39	-	60
Nahanni/Virginia	232	232	216	60
Nahanni	339	339	-	60
Flat	18	18	-	60
Lockhart	387	387	126	60
Pikes Portage	148	148	126	60
Quoich	207	207	-	60
Tha-Anne	41	41	-	60
Taltson	113	113	34	60
Tazzin	15	15	-	60
Thelon	188	188	34	60
Thlewiaza	73	73	-	60
Trout	10	10	6	60
Slave	1130	1130	370	60
Sylvia Grinnell	86	86	6	60
Snowdrift	6	6	-	60
Arctic Red	80	80	-	60
Peel	200	200	-	60
Rat	450	450	-	60
Keele	70	70	-	60
Mountain	70	70	-	60
Root	55	55	-	60
Redstone	135	135	-	60
Dahadinni	160	160	-	60
Willow Lake	20	20	-	60

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Remaining Hydroelectric Potential in Canada* (Continued)

Sites	Gross Potential (MW)	Identified Potential (MW)	Planning Potential (MW)	Capacity** Factor (%)
Lamartre	27	27	-	60
Armshow	20	20	-	60
Anna Maria Port	7	7	-	60
Ward Inlet	15	15	-	60
Petitot	27	27	-	60
Hanbury	246	246	-	60
Prince	4	4	-	60
Maguse	3	3	-	60
Sub total	9 196	9 196	2 446	
OTHER SITES	28	-	-	60
TOTAL ALL SITES	9 224	9 196	2 446	
CANADA TOTAL	179 024	109 578	49 623	

* *Estimated.*

** *Capacity factors have been rounded off. In some cases, capacity factors have been estimated using 61 per cent for hydro and 25 per cent for tidal.*

Ext *Extension.*

Redev *Redevelopment.*

Source: Canadian electric utilities and Energy, Mines and Resources Canada.

Definitions and Abbreviations

Alternating Current (AC): A current that flows alternately in one direction and then in the reverse direction. In North America the standard for alternating current is 60 complete cycles each second. Such electricity is said to have a frequency of 60 hertz. Alternating current is used universally in power systems because it can be transmitted and distributed much more economically than direct current.

Base Load: The minimum continuous load over a given period of time.

British Thermal Unit (BTu): A unit of heat. The quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit.

Capacity: In the electric power industry, capacity has two meanings:

1. System Capacity: The maximum power capability of a system. For example, a utility system might have a rated capacity of 5000 megawatts, or might sell 50 megawatts of capacity (i.e. of power).

2. Equipment Capacity: The maximum power capability of a piece of equipment. For example, a generating unit might have a rated capacity of 50 megawatts.

Capacity Factor: For any equipment, the ratio of the average load during some time period to the rated capacity.

Cogeneration: A cogenerating system produces electricity and heat in tandem. Such systems have great potential in industry, where a significant requirement for electricity is coupled with a large demand for process steam.

Consumer Price Index (CPI): A measure of the percentage change over time in the cost of purchasing a constant "basket" of goods and services. The basket consists of items for which there are continually measurable market prices, so that changes in the cost of the basket are due only to price movements.

Consumption: Use of electrical energy, typically measured in kilowatt hours.

Conventional Generation: Electricity that is produced at a generating station where the prime movers are driven by gases or steam produced by burning fossil fuels.

Current: The flow of electricity in a conductor. Current is measured in amperes.

Demand Charge: The component of a two-part price for electricity that is based on a customer's highest power demand reached in a specified period, usually a month, regardless of the quantity of energy used (e.g. $2.00 per kilowatt per month). The other component of the two-part price is the energy charge.

Direct Current (DC): Current that flows continuously in the same direction (as opposed to alternating current). The current supplied from a battery is direct current.

Economy Energy: Energy sold by one power system to another, to effect a saving in the cost of generation when the receiving party has adequate capacity to supply the loads from its own system.

Electrical Energy: The quantity of electricity delivered over a period of time. The commonly used unit of electrical energy is the kilowatt-hour (kW.h).

Electrical Power: The rate of delivery of electrical energy and the most frequently used measure of capacity. The basic unit is the kilowatt (kW).

Energy Charge: The component of a two-part price for electricity which is based on the amount of energy taken (e.g. 20 mills per kW.h). The other component of the price is the demand charge.

Energy Source: The primary source that provides the power that is converted to electricity. Energy sources include coal, petroleum and petroleum products, gas, water, uranium, wind, sunlight, geothermal, and other sources.

Firm Energy or Power: Electrical energy or power intended to be available at all times during the period of the agreement for its sale.

Frequency: The number of cycles through which an alternating current passes in a second. The North American standard is 60 cycles per second, known as 60 hertz.

Gigawatt (GW): One billion watts. (See Watt.)

Gigawatt hour (GW.h): A unit of bulk energy. A million kilowatt hours. A billion watt hours.

Grid: A network of electric power lines and connections.

Gross Domestic Product (GDP): The total value of goods and services produced in Canada. GDP measured in constant dollars is defined as Real GDP.

Gross National Product (GNP): The total value of production of goods and services measured at market prices.

Hertz (Hz): The unit of frequency for alternating current. Formerly called cycles per second. The standard frequency for power supply in North America is 60 Hz.

Installed Capacity: The capacity measured at the output terminals of all the generating units in a station, without deducting station service requirements.

Interruptible Energy or Power: Energy or power made available under an agreement that permits curtailment or interruption of delivery at the option of the supplier.

Joule: The international unit of energy. The energy produced by a power of one watt flowing for one second. The joule is a very small unit: there are 3.6 million joules in a kilowatt hour.

Kilovolt (kV): 1000 volts.

Kilowatt (kW): The commercial unit of electric power; 1000 watts. A kilowatt can best be visualized as the total amount of power needed to light ten 100-watt light bulbs.

Kilowatt hour (kW.h): The commercial unit of electric energy; 1000 watt hours. A kilowatt hour can best be visualized as the amount of electricity consumed by ten 100-watt light bulbs burning for an hour. One kilowatt hour is equal to 3.6 million joules.

Load: The amount of electric power or energy consumed by a particular customer or group of customers.

Load Factor: The ratio of the average load during a designated period to the peak or maximum load in that same period. (Usually expressed in per cent.)

Megawatt (MW): A unit of bulk power; 1000 kilowatts.

Megawatt hour (MW.h): A unit of bulk energy; 1000 kilowatt hours.

Mill: 1/1000 of a dollar.

Net Exports: Total exports minus total imports.

Nuclear Power: Power generated at a station where the steam to drive the turbines is produced by an atomic process, rather than by burning a combustible fuel such as coal, oil or gas.

Peak Demand: The maximum power demand registered by a customer or a group of customers or a system in a stated period of time such as a month or a year. The value may be the maximum instantaneous load or more usually the average load over a designated interval of time, such as one hour, and is normally stated in kilowatts or megawatts.

Power System: All the interconnected facilities of an electrical utility. A power system includes all the generation, transmission, distribution, transformation, and protective components necessary to provide service to the customers.

Primary Energy Source: The source of primary energy from which electricity is generated. This may be falling water, uranium (by nuclear fission), coal, oil, natural gas, wind, tidal energy, etc.

Reserve Generating Capacity: The extra generating capacity required on any power system over and above the expected peak load. Such a reserve is required mainly for two reasons: (i) in case of an unexpected breakdown of generating equipment; (ii) in case the actual peak load is higher than forecast.

Terawatt Hours (TW.h): One billion kilowatt hours.

Voltage: The electrical force or potential that causes a current to flow in a circuit (just as pressure causes water to flow in a pipe). Voltage is measured in volts (V) or kilovolts (kV). 1 kV = 1000 V.

Watt: The scientific unit of electric power; a rate of doing work at the rate of one joule per second. A typical light bulb is rated 25, 40, 60 or 100 watts, meaning that it consumes that amount of power when illuminated. A horse power is 746 watts.